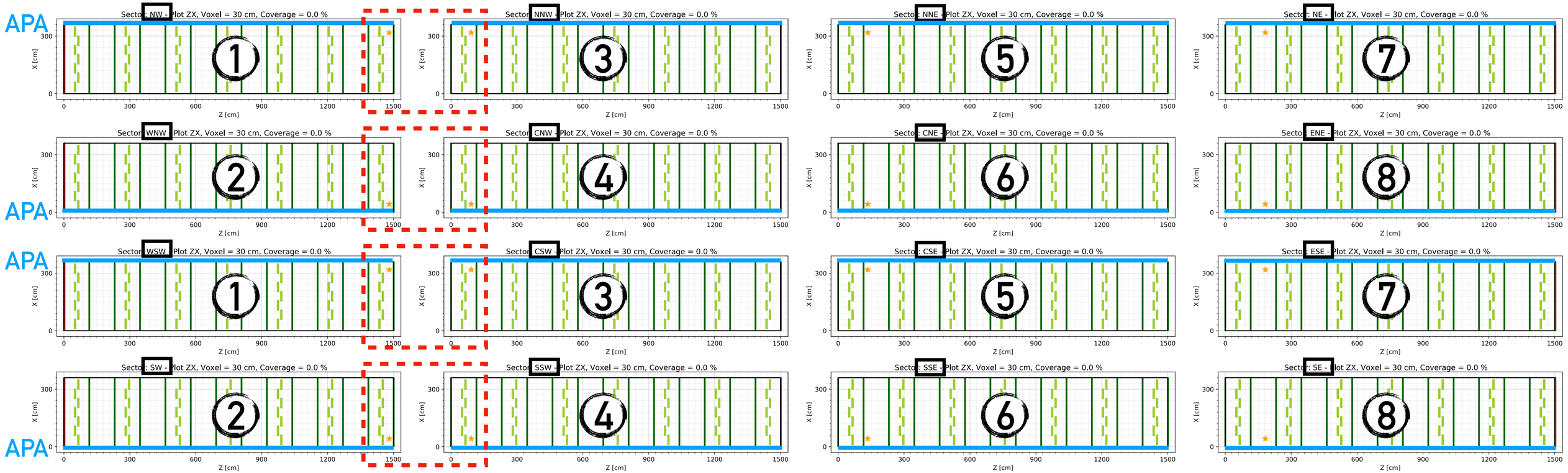
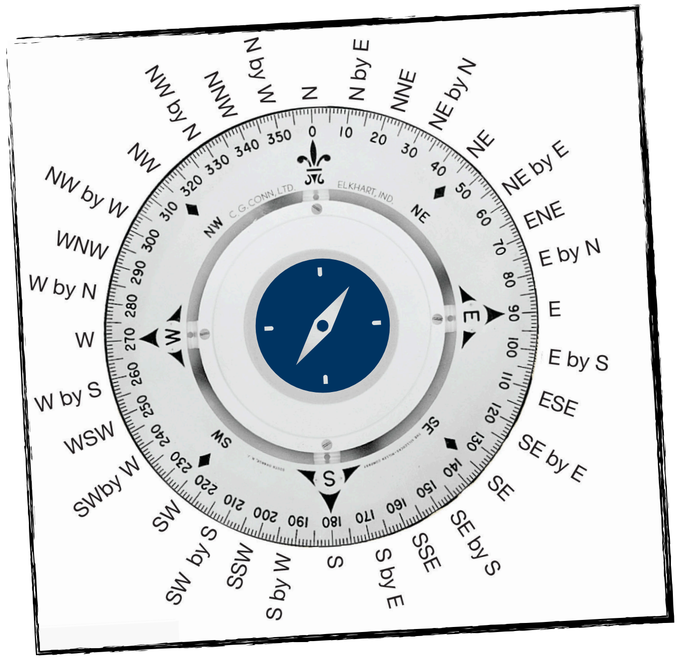
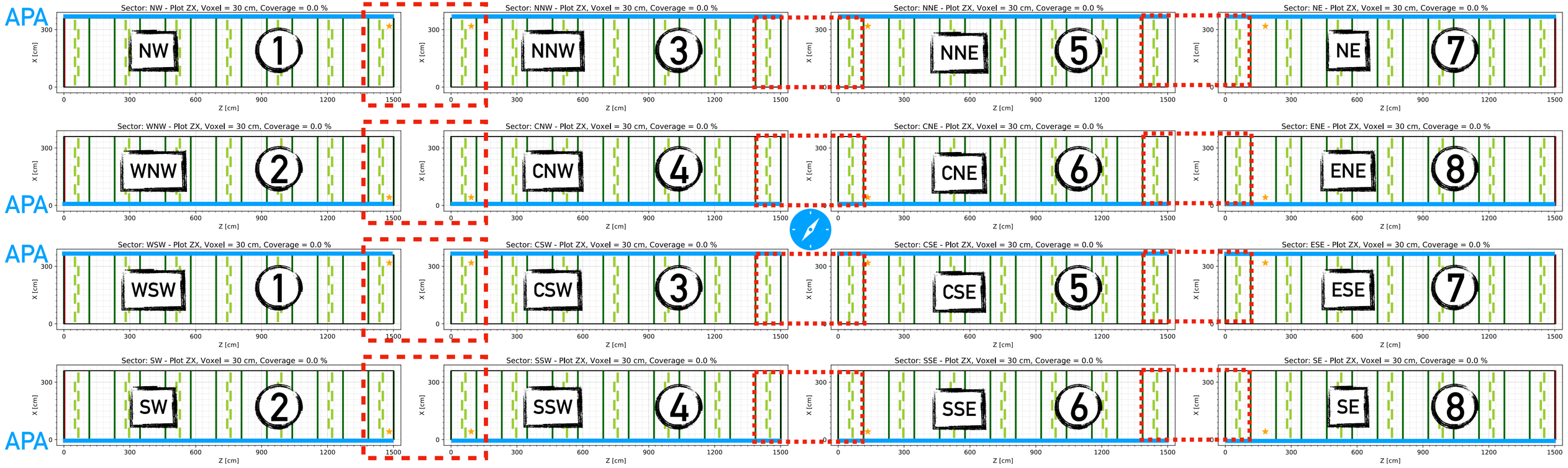
Simulation update

Mattia - Mar 10, 2021


APA
Sector: NW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: NNW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: NNE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: NE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
1
3
5
7
Sector: WNW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: CNW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: CNE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: ENE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
2
4
6
8
APA
APA
Sector: WSW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: CSW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: CSE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: ESE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
1
3
5
7
Sector: SW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: SSW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: SSE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
Sector: SE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
2
4
6
8
APA
X [cm]
Z [cm]
0
300
600
900
1200
1500

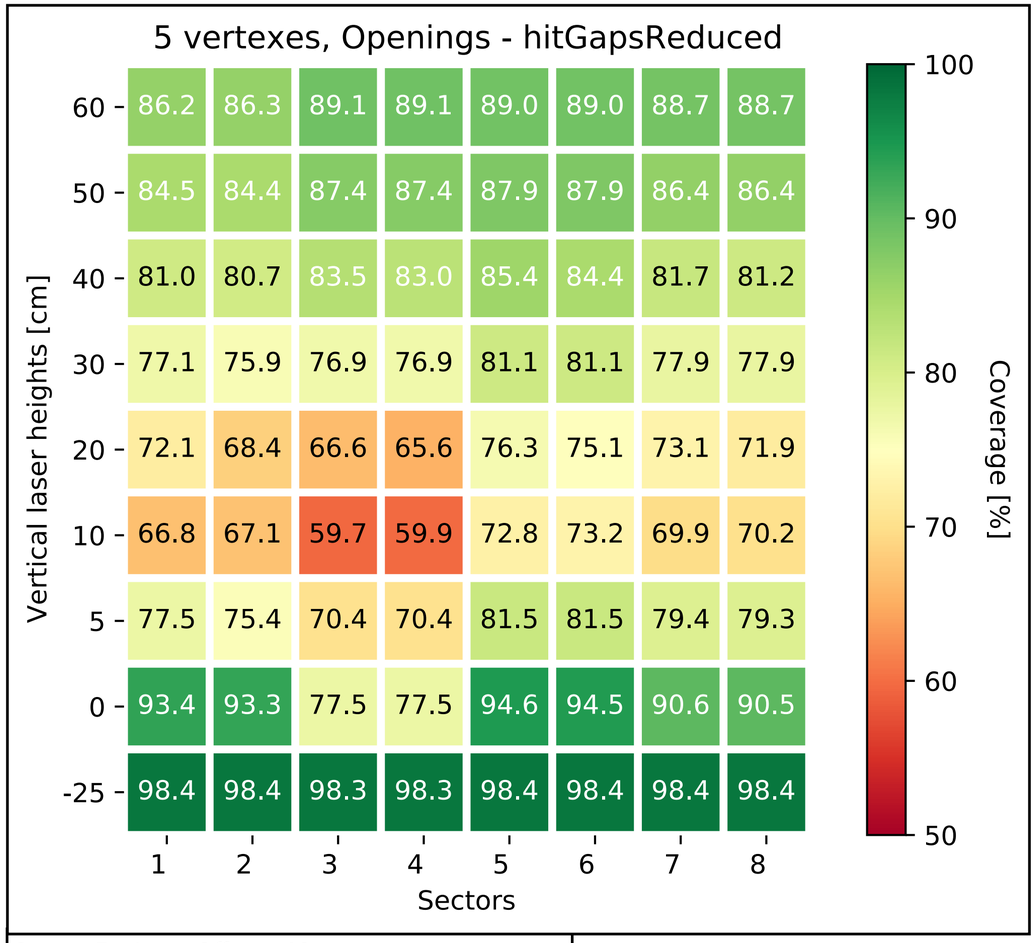
Revised sector map



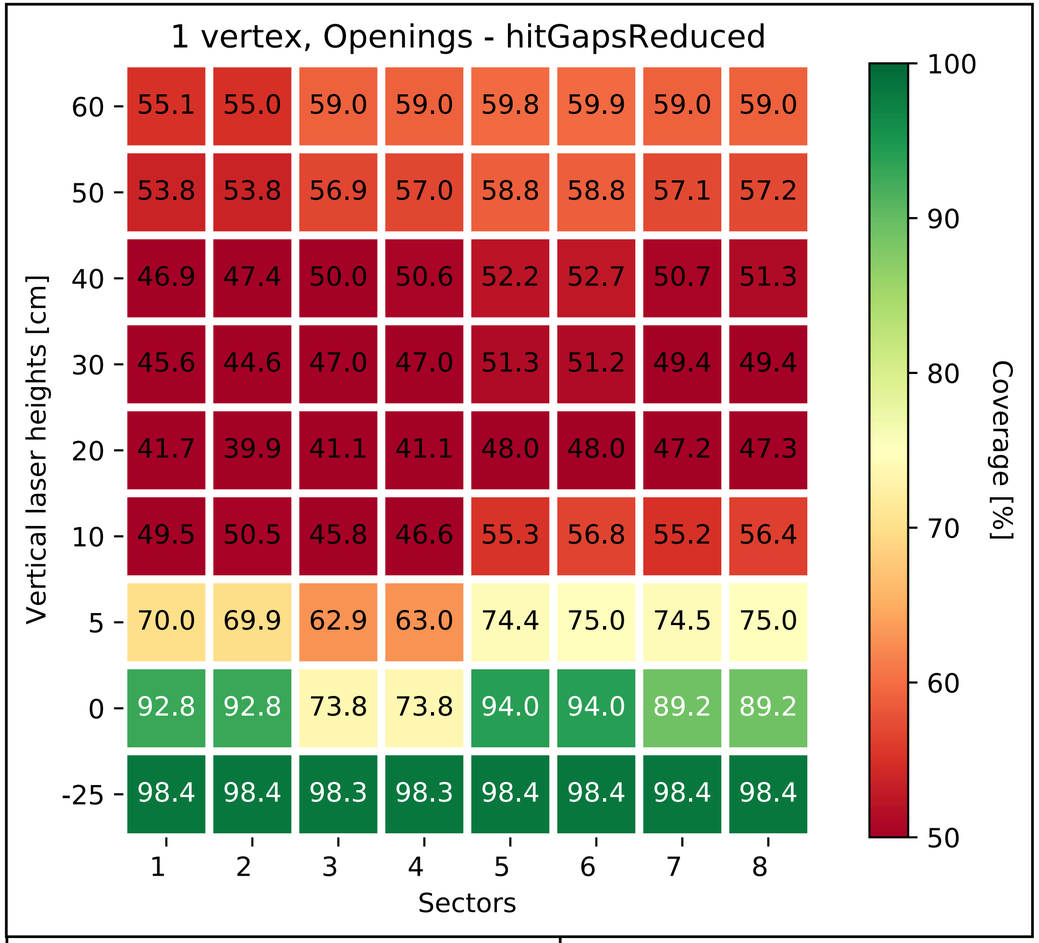


Openings,
NoAPA, Obs,
Voxel = 30 cm

Results from Top-FC simulation

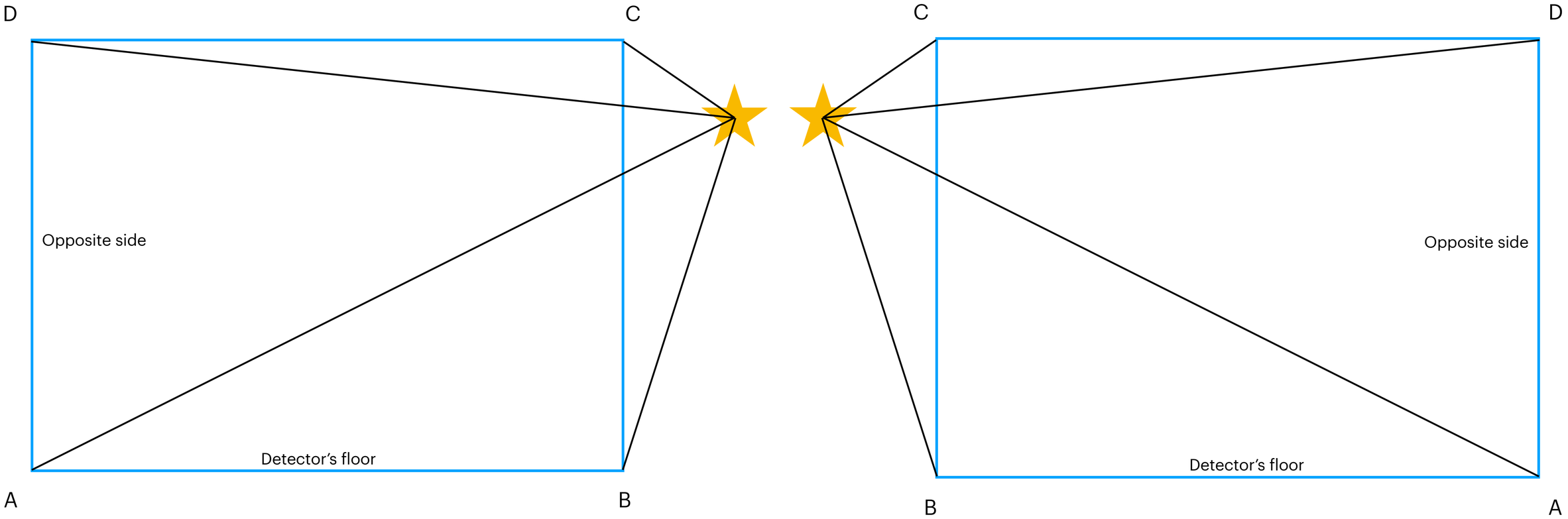


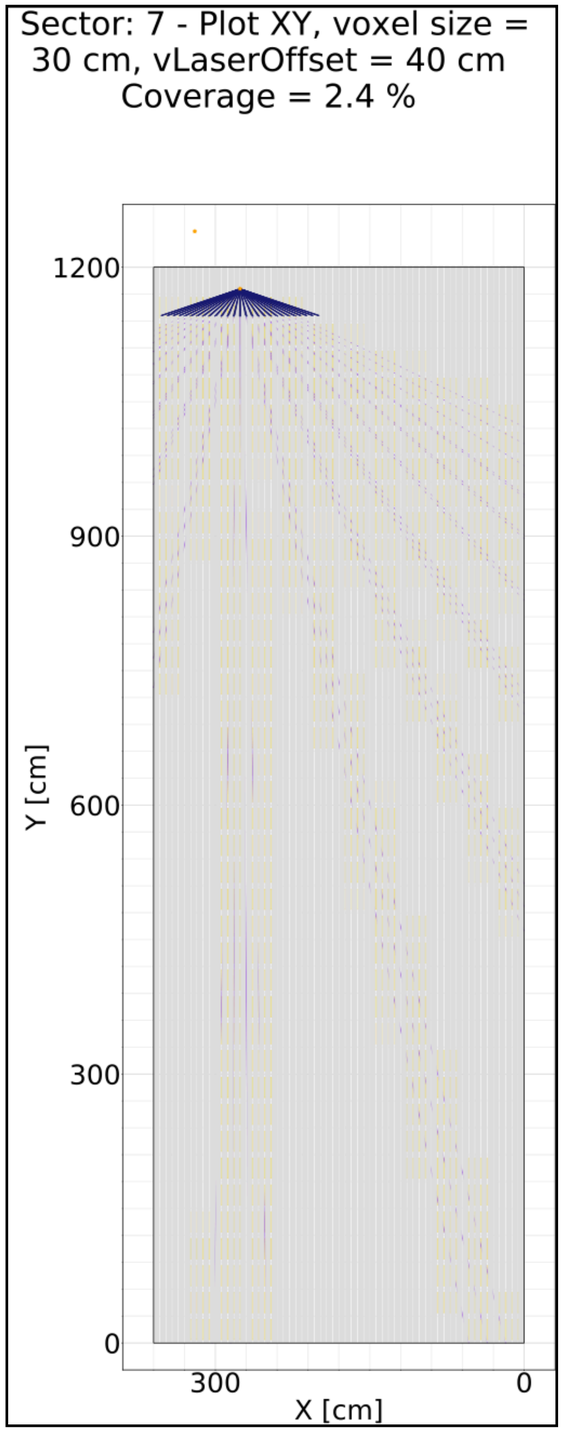
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **34718**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 18443
Number of rays crossing the active region: 16275
Computing coverage for the single sources...
Covered voxels Source 0: 20486 of 24000;
Coverage Source 0 = 85.4%

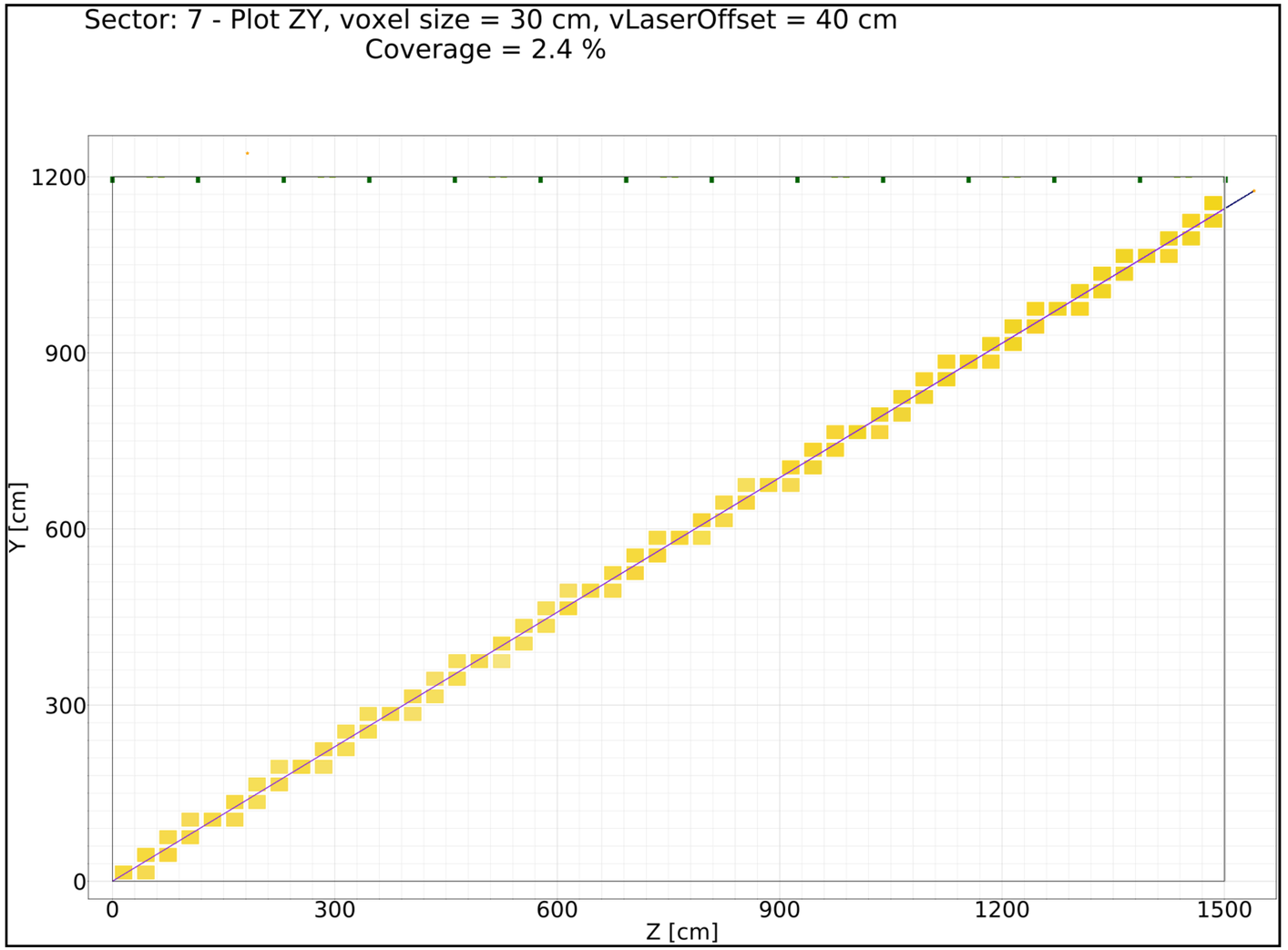


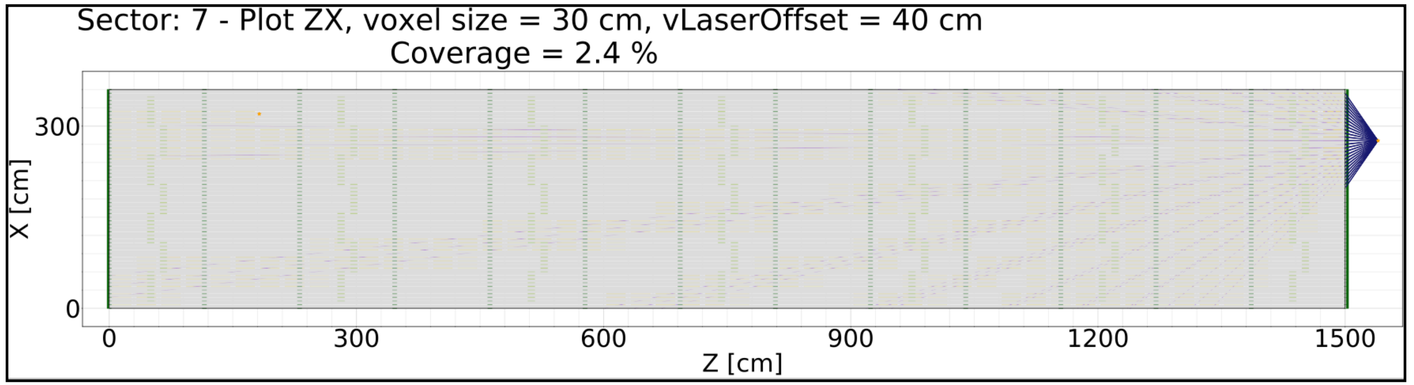
Sector 5, vLaserOffset= 40
Track summary
Number of total generated tracks: **6613**
Number of rays not crossing the detector: 0
Number of rays blocked by obstacles: 3694
Number of rays crossing the active region: 2919
Computing coverage for the single sources...
Covered voxels Source 0: 12528 of 24000;
Coverage Source 0 = 52.2%

End-wall study



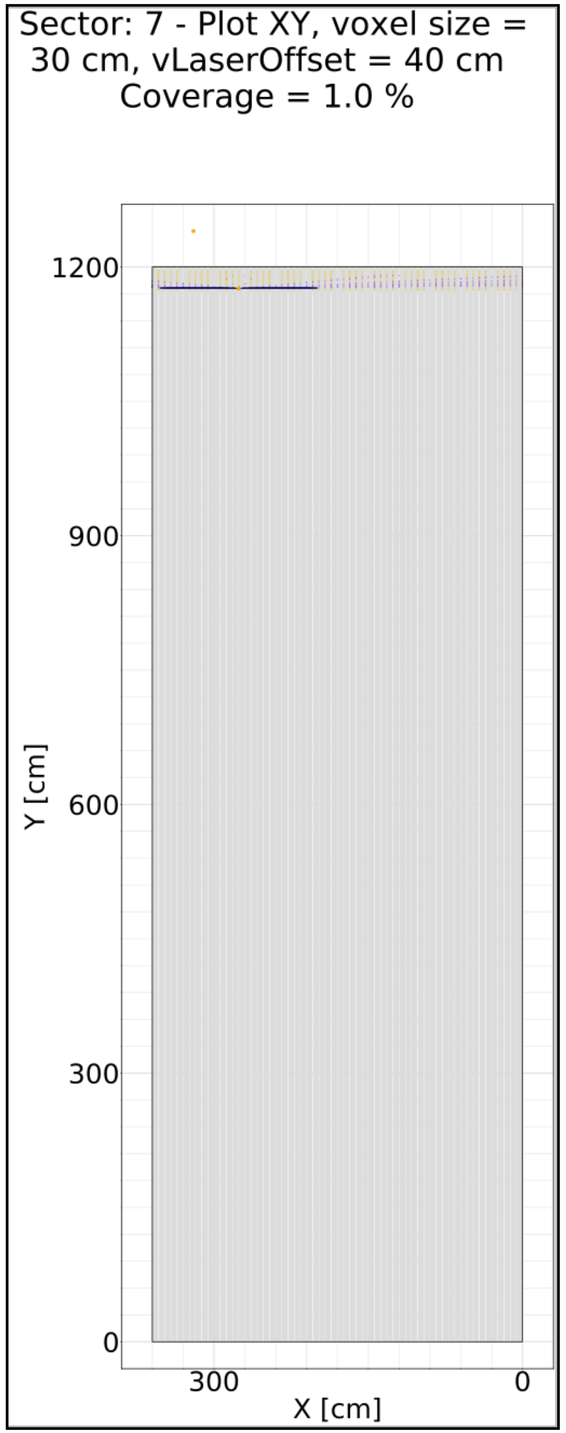


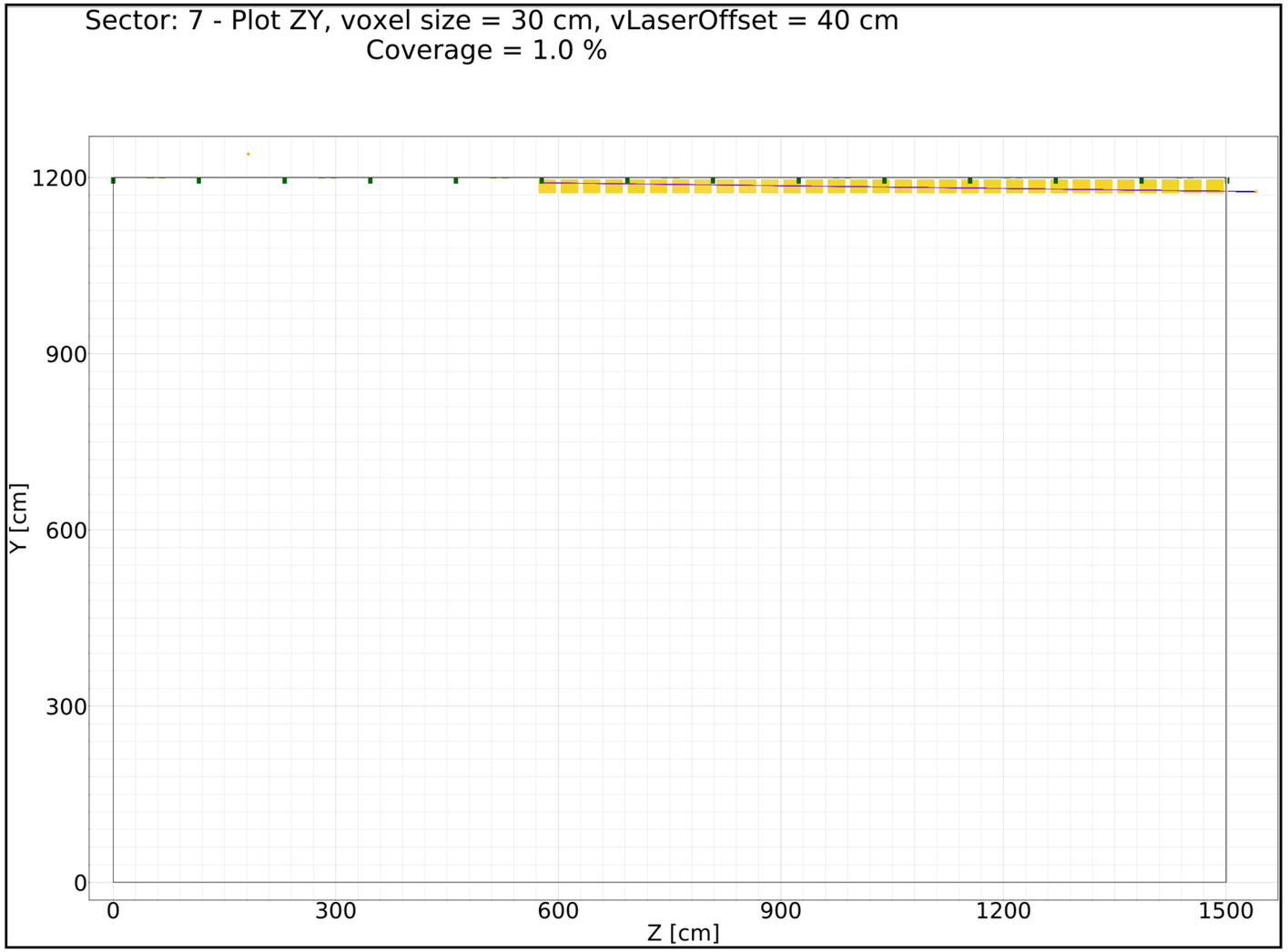


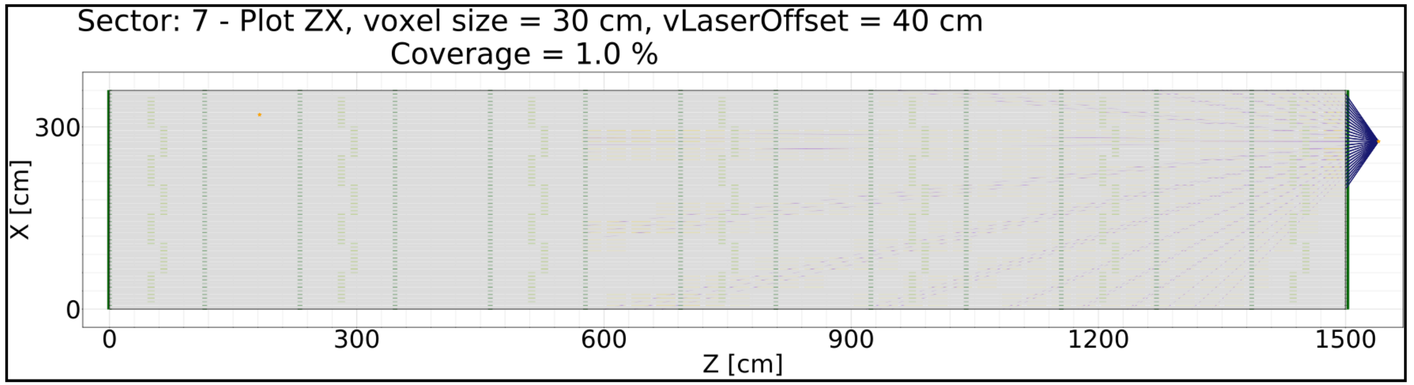


Step_00

- Correct x-propagation
- Hit Opposite corners





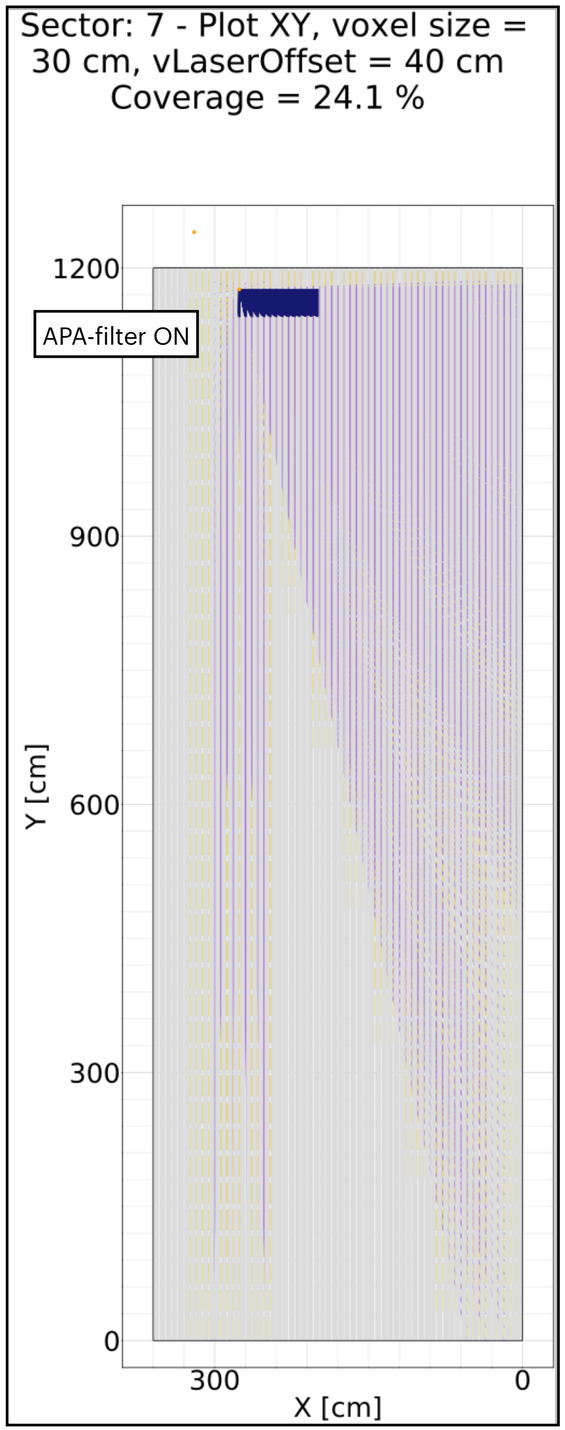


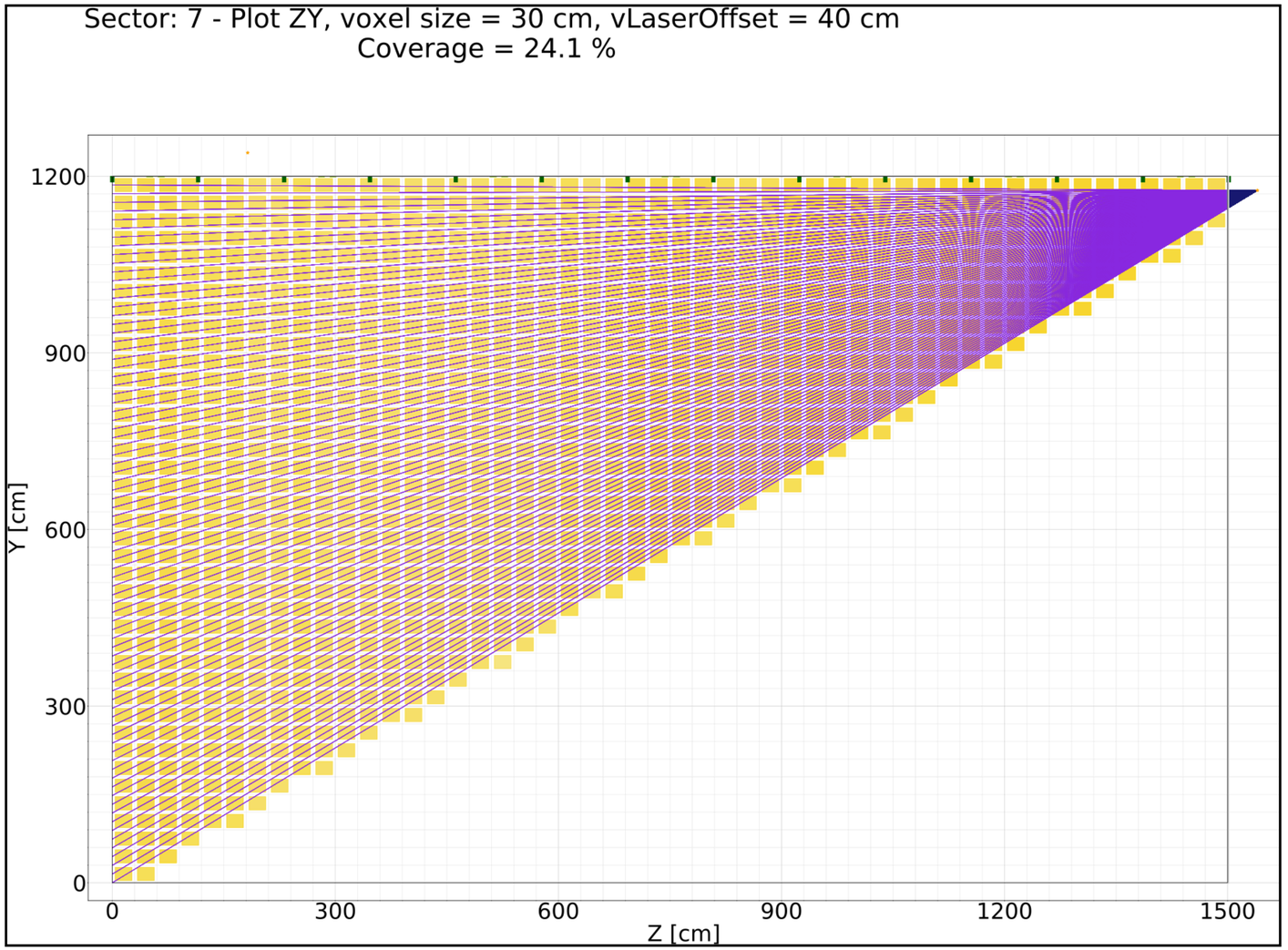
Step_00

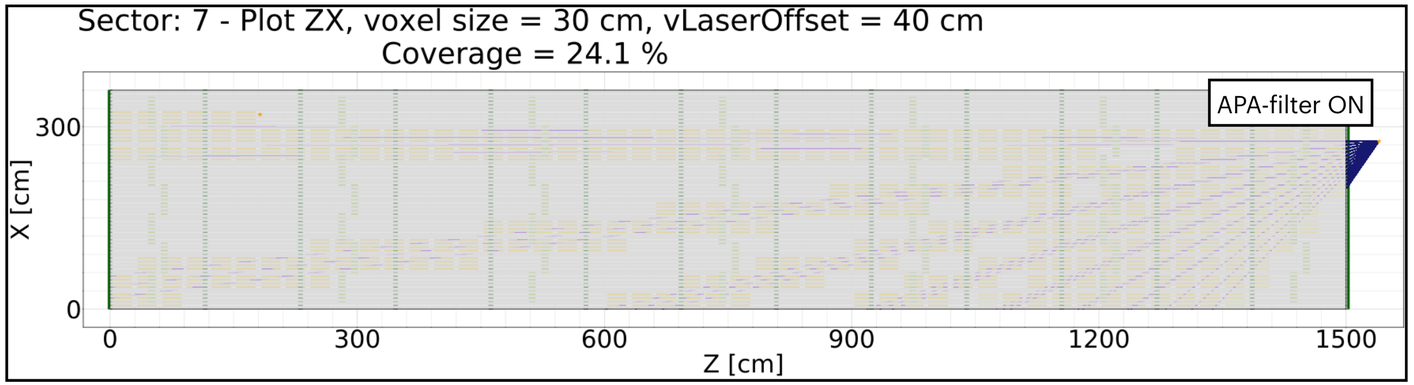
- Correct x-propagation
- Hit Opposite corners

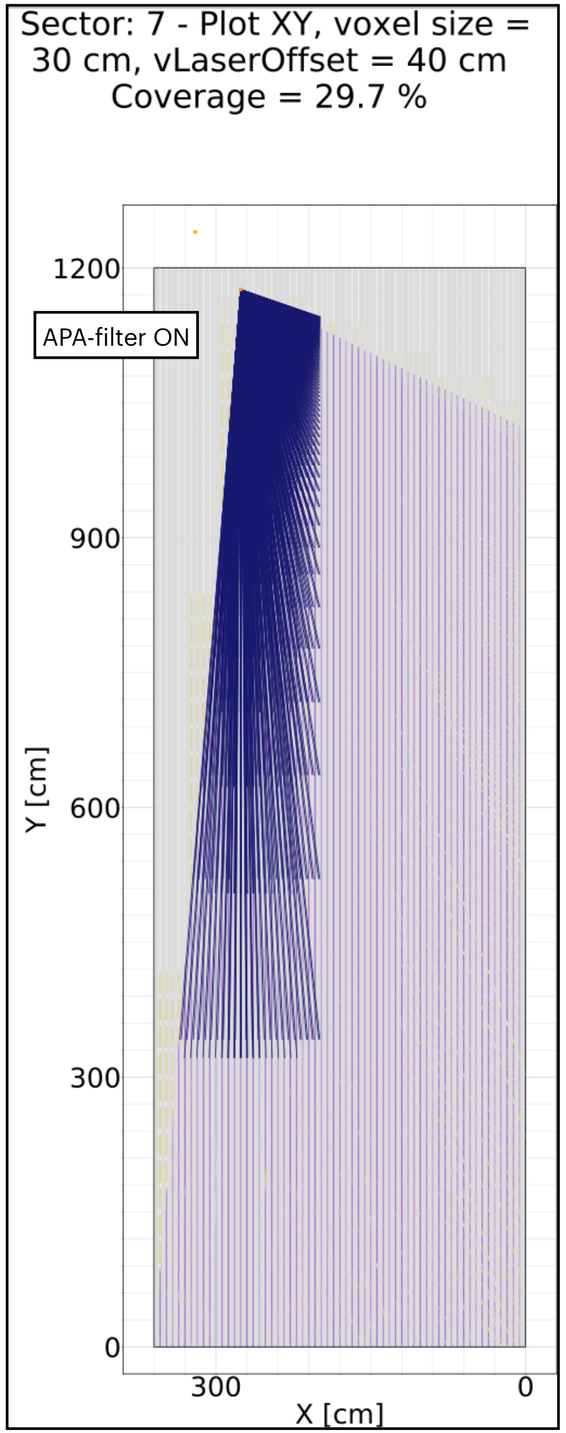
Step_01

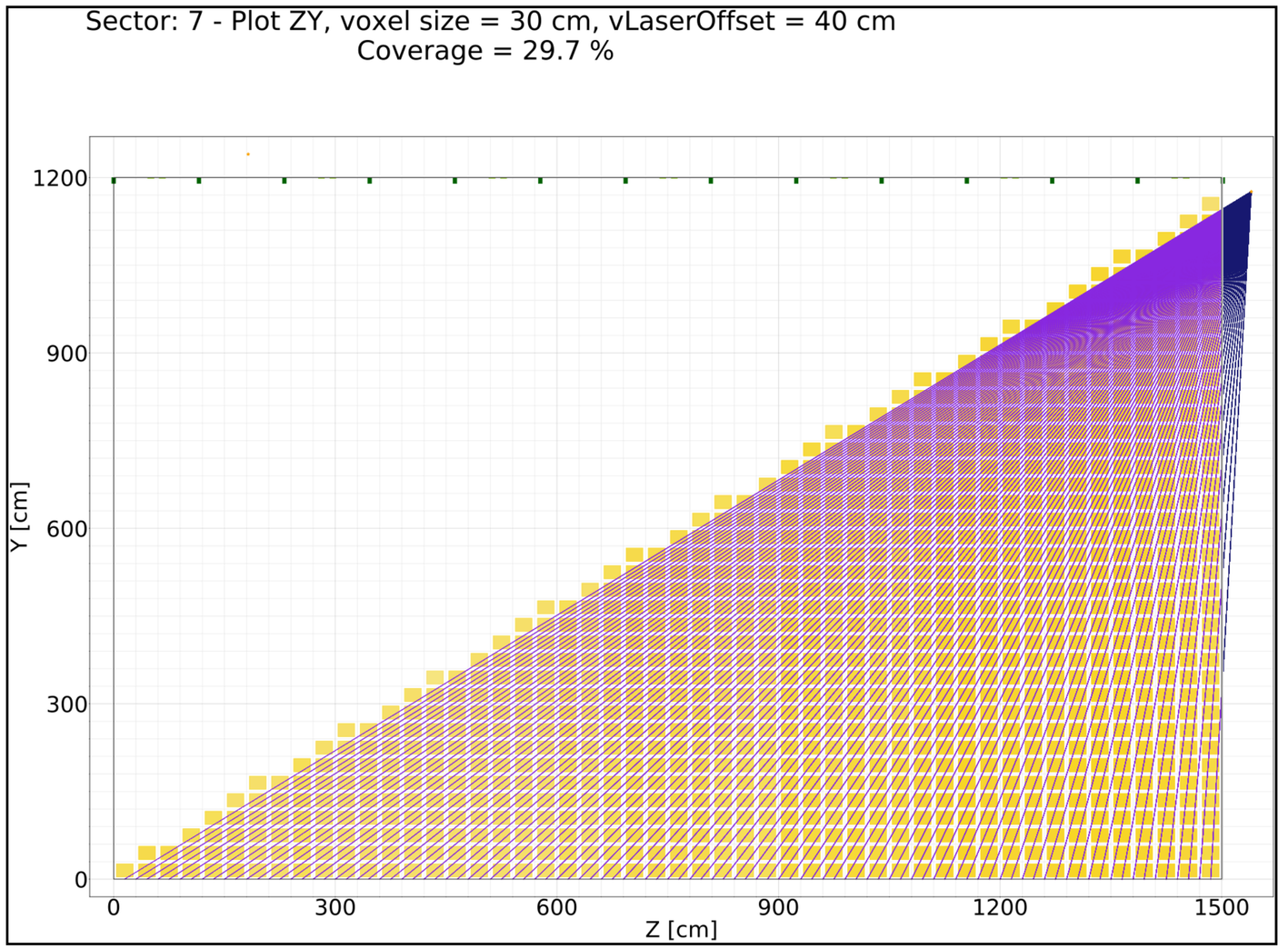
- Fill opposite side at the desired arrival density (given in input)

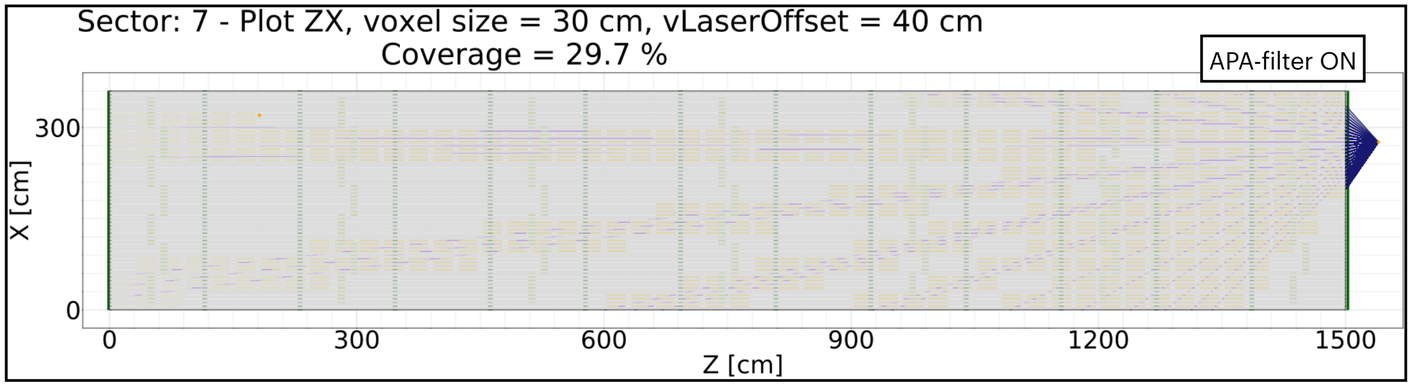










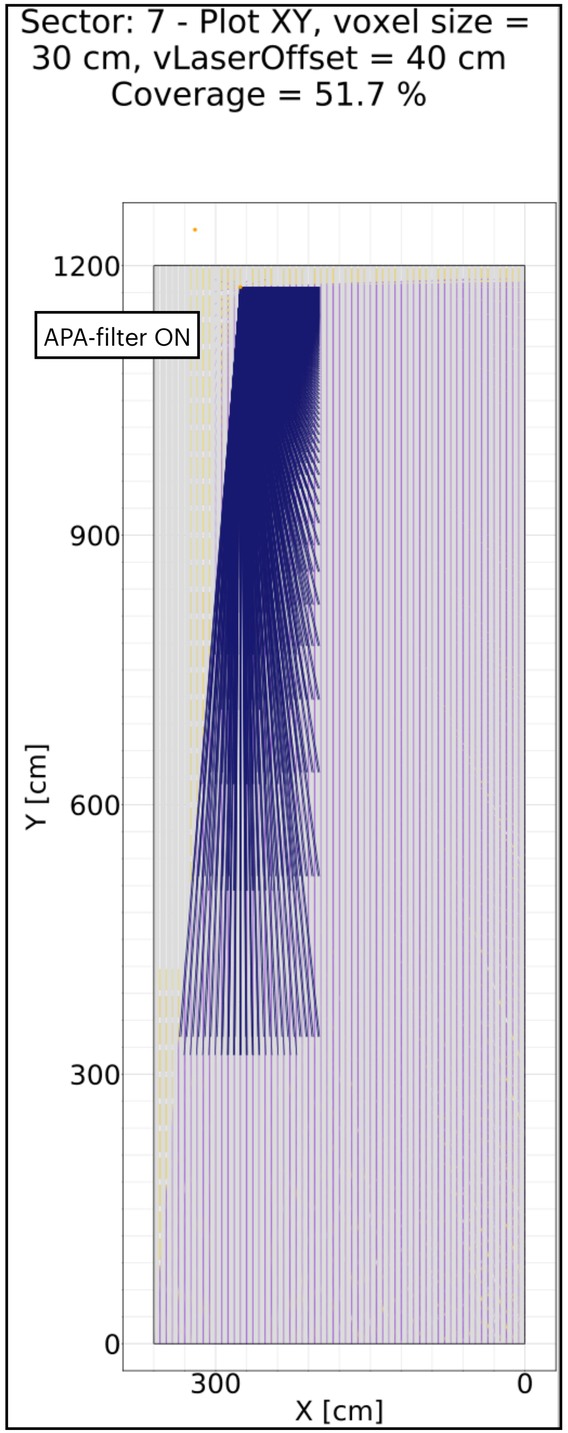


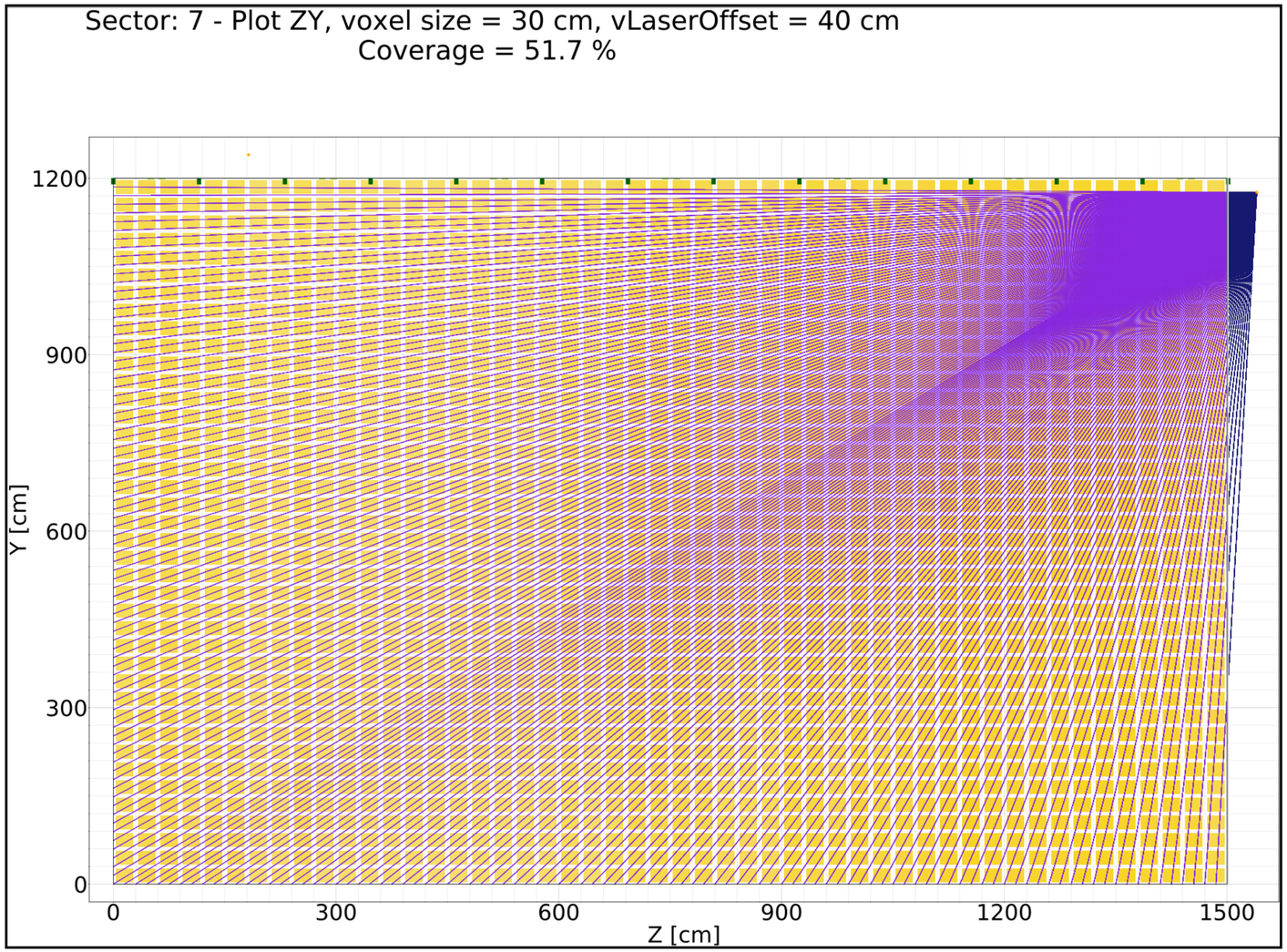
Step_02

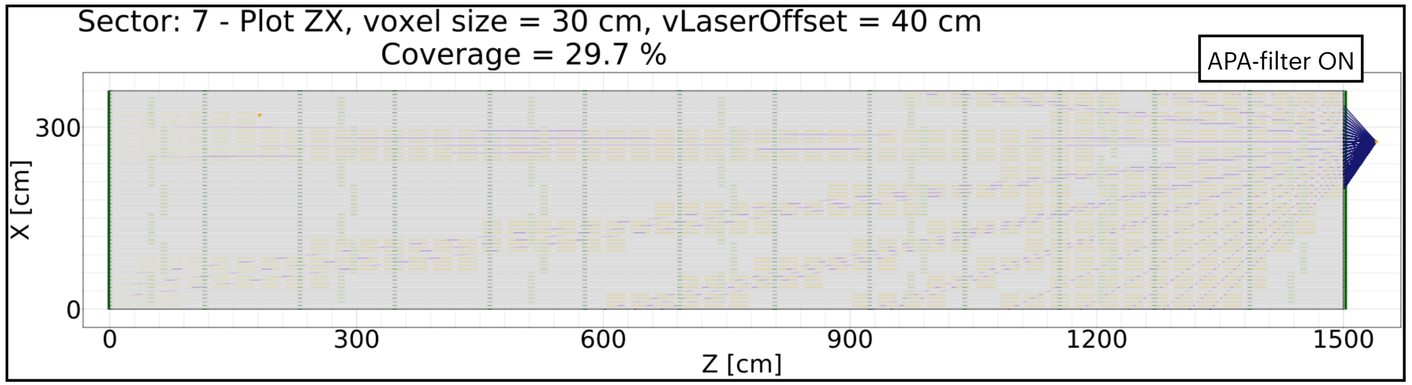
- Fill detector floor at the desired arrival density (given in input)
- Apply reductions
- Effect of APA-filtering is no longer negligible as it was in the Top-FC case

Step_03

- Considering all the contributions

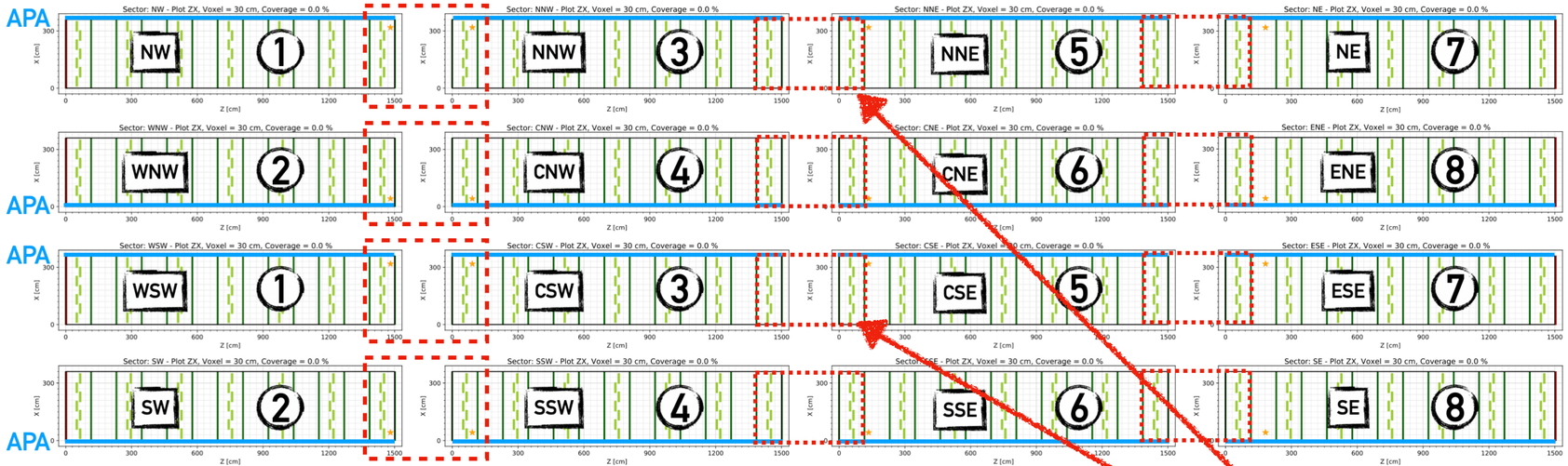


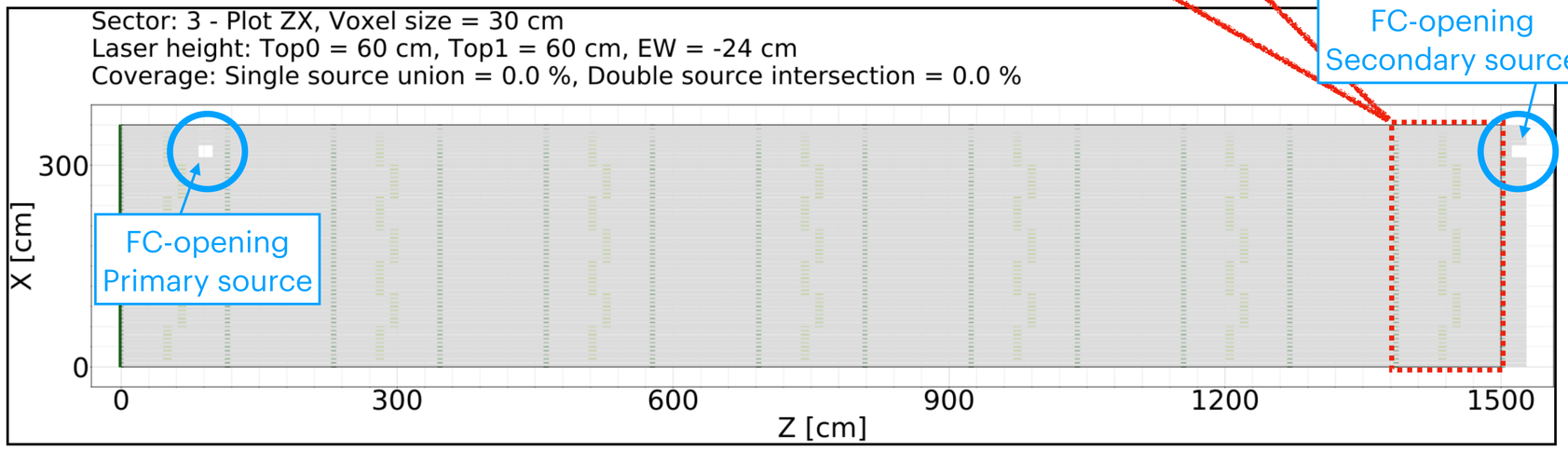




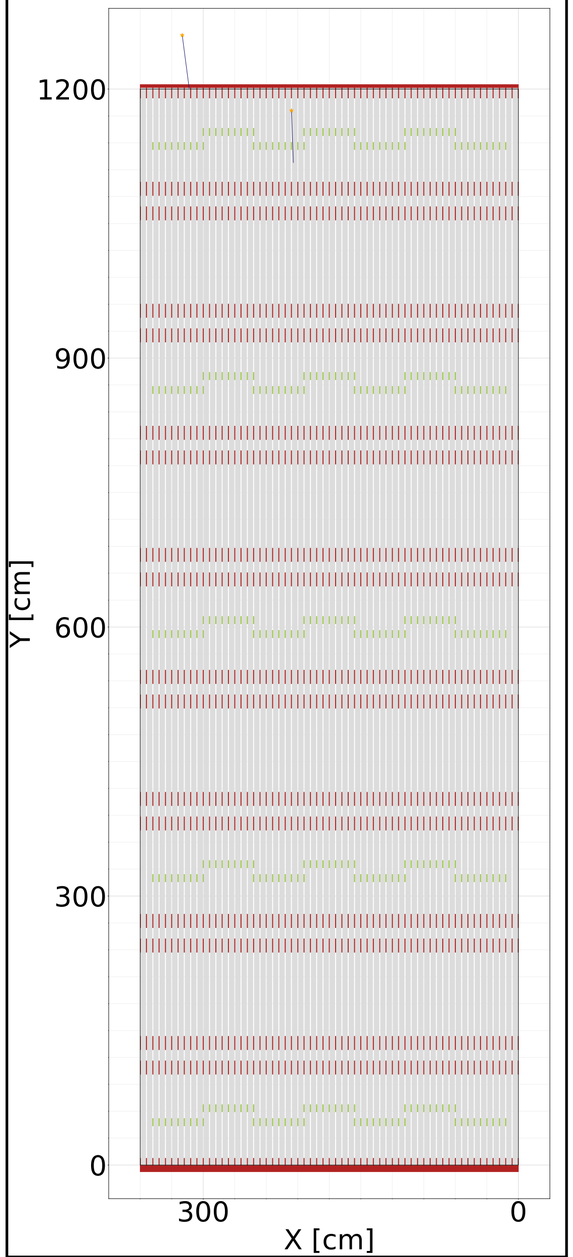
Integrating in the two-sources scheme

```python
if __name__ == "__main__":

    ###########################################################################
    ### Defining parameters
    ###########################################################################

    print("\nRunning", sys.argv[0])
    print(" Total arguments passed:", len(sys.argv))

    if len(sys.argv) == 15:

        voxelSize               = np.int(sys.argv[1])
        sector                  = str(sys.argv[2])
        raySet                  = str(sys.argv[3])
        ifSource0               = str(sys.argv[4])
        ifSource1               = str(sys.argv[5])
        nVertices               = np.int(sys.argv[6])
        angleOffset             = ((int(sector))+1)%2 * 36 #np.int(sys.argv[7])
        vLaserOffsetTop0        = np.int(sys.argv[8])
        vLaserOffsetTop1        = np.int(sys.argv[9])
        vLaserOffsetEW          = np.int(sys.argv[10])
        ifAPA                   = str(sys.argv[11])
        ifStdObstacles          = str(sys.argv[12])
        ifGraphicOutput         = str(sys.argv[13])
        ifLargePlot             = str(sys.argv[14])

        ifAPA = castForBools(ifAPA)
        ifStdObstacles = castForBools(ifStdObstacles)
        ifGraphicOutput = castForBools(ifGraphicOutput)
        ifLargePlot = castForBools(ifLargePlot)

    else:

        voxelSize = 30
        sector = '3' #NNW
        raySet = 'FinalRaySet'
        ifSource0 = True
        ifSource1 = True
        nVertices = 1
        angleOffset = 0 #((int(sector))+1)%2 * 36 # odd: 0, even: 36
        vLaserOffsetTop0 = 60
        vLaserOffsetTop1 = -24
        vLaserOffsetEW = -24
        ifAPA = False
        ifStdObstacles = True
        ifGraphicOutput = True
        ifLargePlot = True


    inc.GV.globalVariables(voxelSize, vLaserOffsetTop0, vLaserOffsetTop1, vLaserOffsetEW)

    ###########################################################################

    ###########################################################################
    ### Building detector
    ###########################################################################

    if ifStdObstacles == True:
```

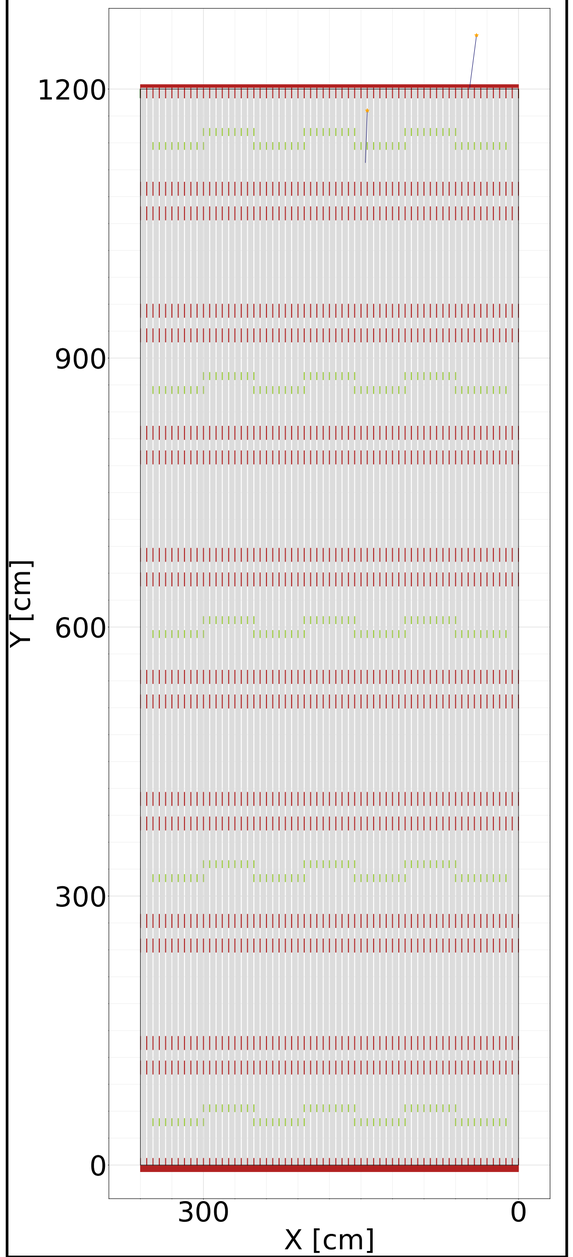




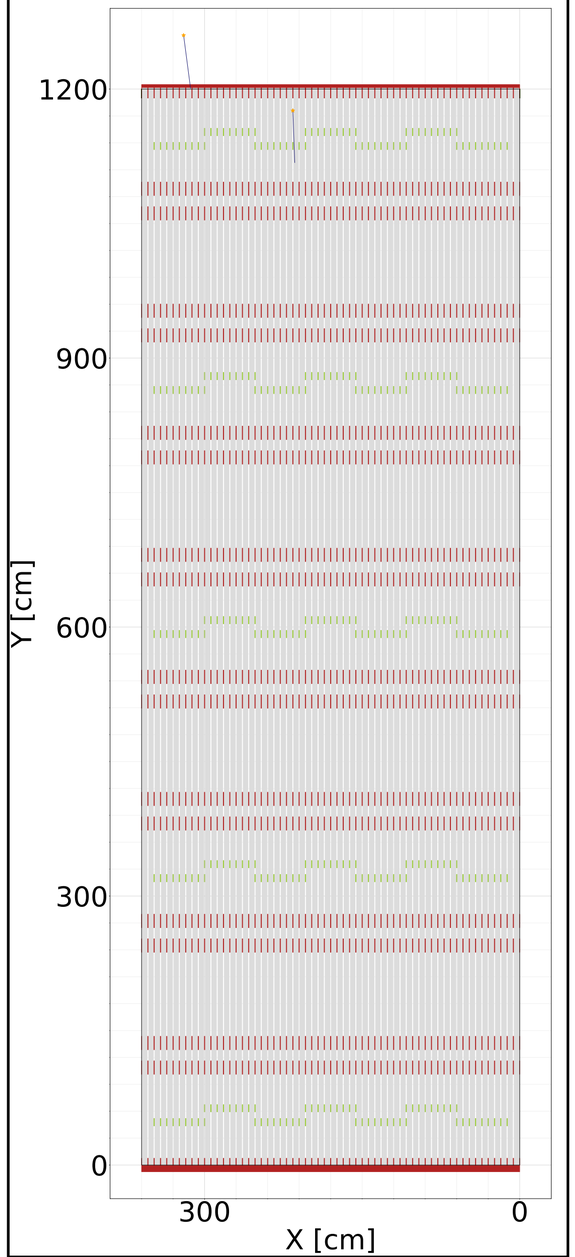
Sector: NW - Plot XY, Voxel size = 30 cm
Laser height:
Top0 = 60 cm, Top1 = 60 cm, EW = -24 cm
Coverage:
Single source union = 0.0 %
Double source intersection = 0.0 %



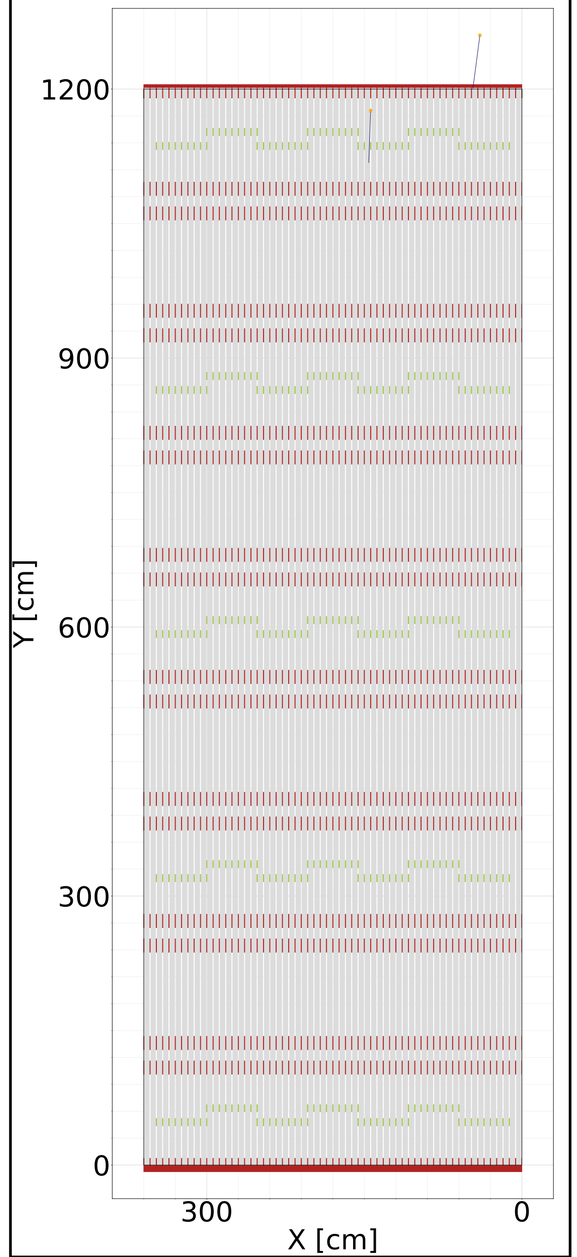
Sector: WNW - Plot XY, Voxel size = 30 cm
Laser height:
Top0 = 60 cm, Top1 = 60 cm, EW = -24 cm
Coverage:
Single source union = 0.0 %
Double source intersection = 0.0 %

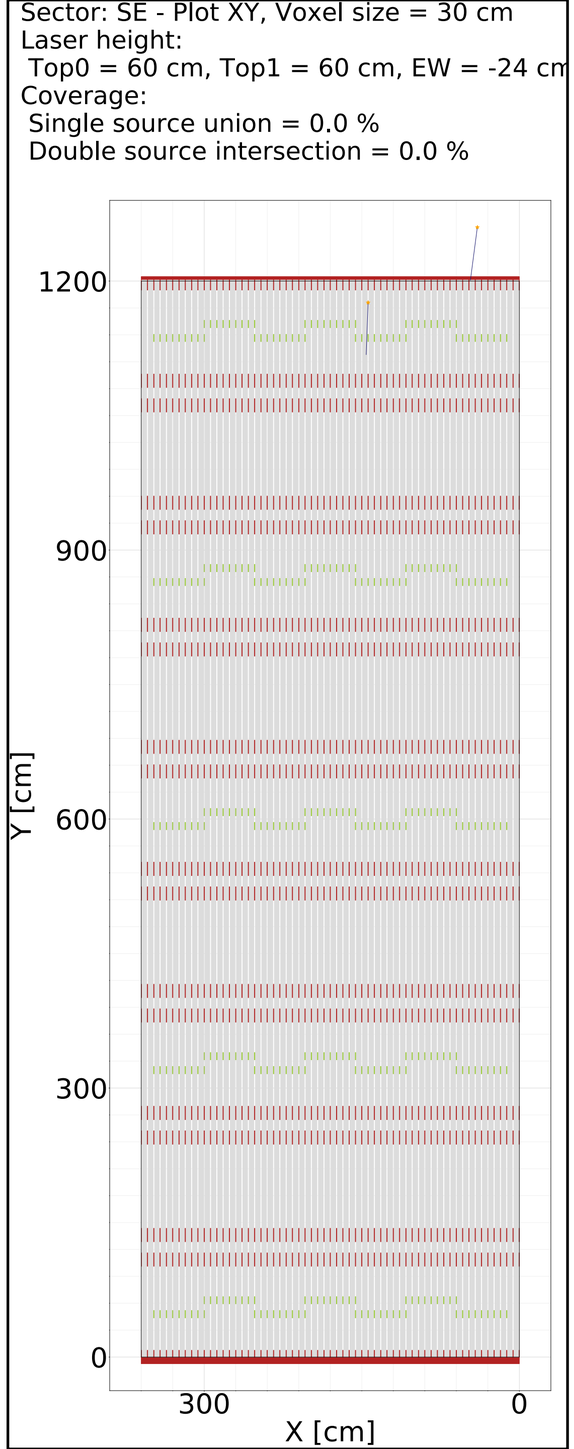


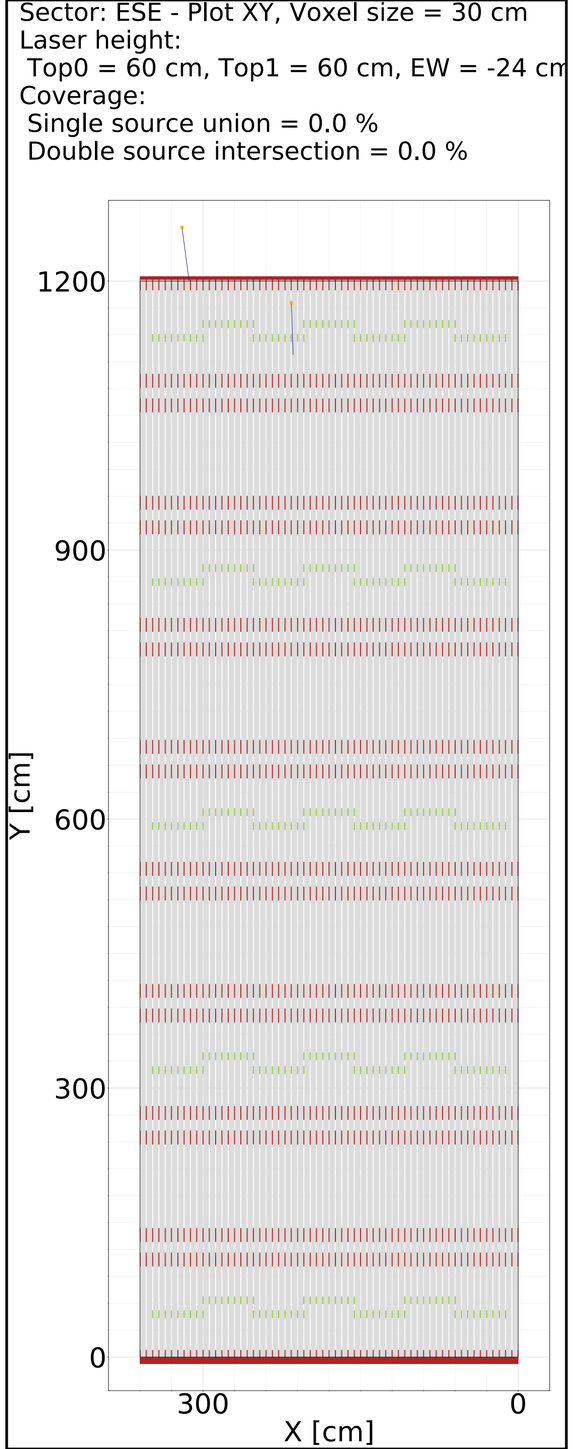
Sector: WSW - Plot XY, Voxel size = 30 cm
Laser height:
Top0 = 60 cm, Top1 = 60 cm, EW = -24 cm
Coverage:
Single source union = 0.0 %
Double source intersection = 0.0 %

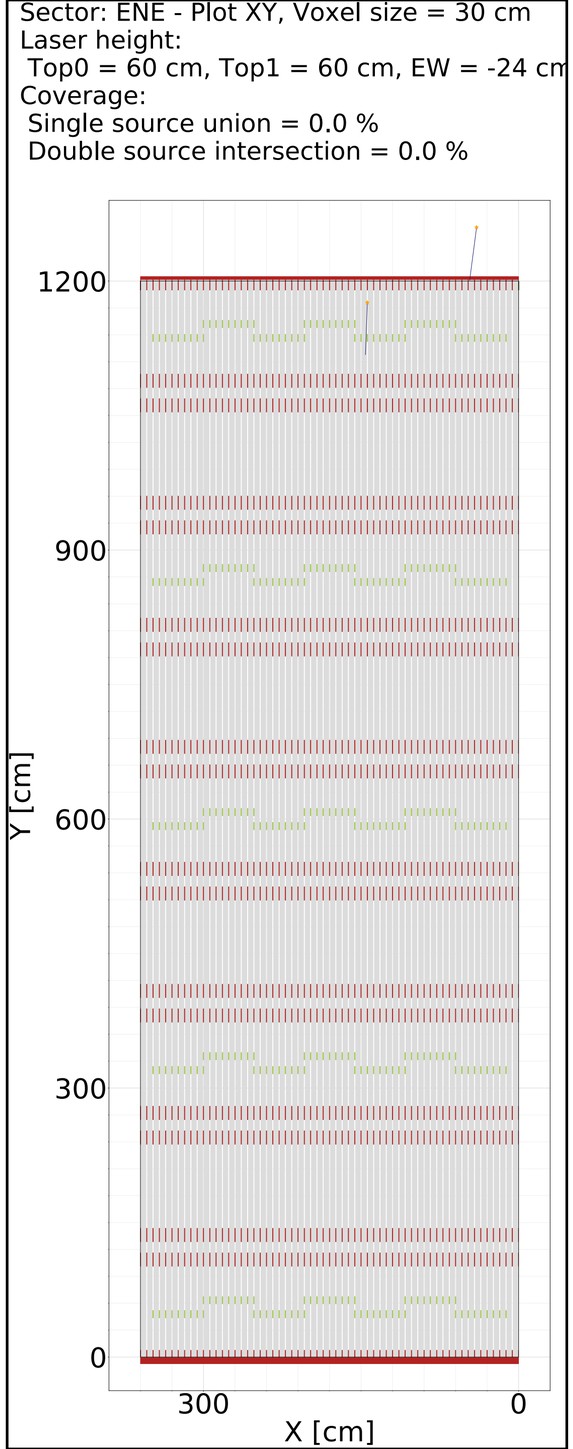


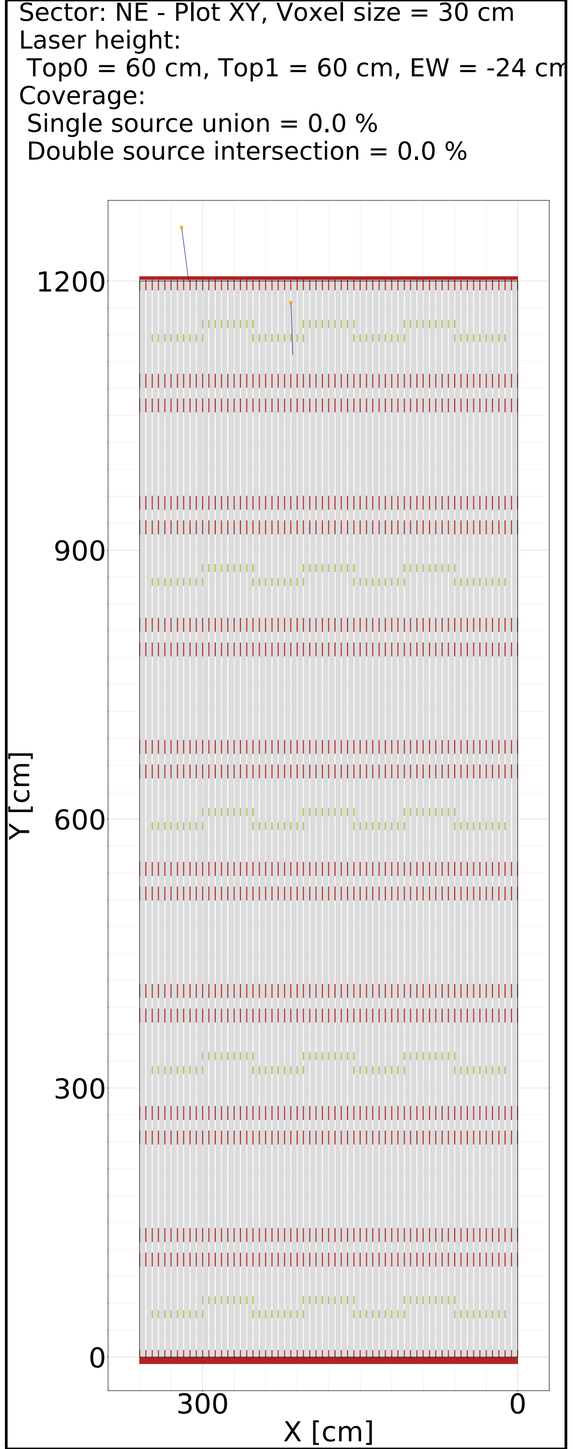
Sector: SW - Plot XY, Voxel size = 30 cm
Laser height:
Top0 = 60 cm, Top1 = 60 cm, EW = -24 cm
Coverage:
Single source union = 0.0 %
Double source intersection = 0.0 %




Sector: SE - Plot XY, Voxel size = 30 cm
Laser height:
Top0 = 60 cm, Top1 = 60 cm, EW = -24 cm
Coverage:
Single source union = 0.0 %
Double source intersection = 0.0 %
1200
900
600
300
0
Y [cm]
300
0
X [cm]


Sector: ESE - Plot XY, Voxel size = 30 cm
Laser height:
Top0 = 60 cm, Top1 = 60 cm, EW = -24 cm
Coverage:
Single source union = 0.0 %
Double source intersection = 0.0 %
1200
900
600
300
0
Y [cm]
300
0
X [cm]

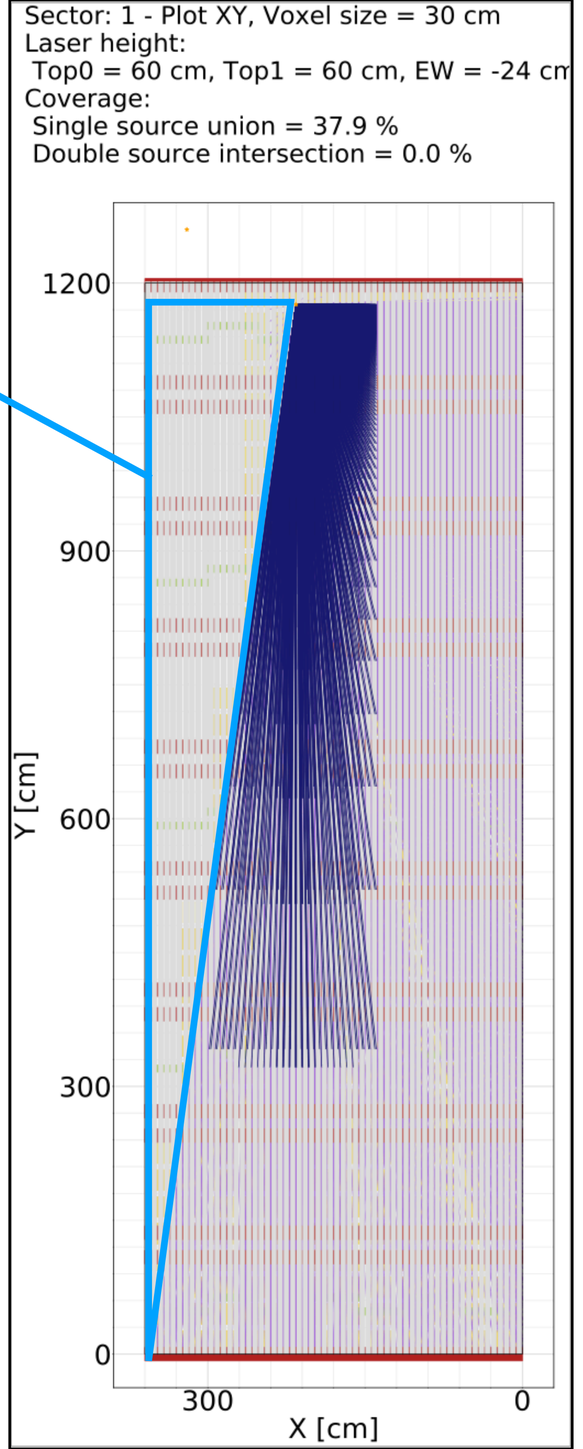

Sector: ENE - Plot XY, Voxel size = 30 cm
Laser height:
Top0 = 60 cm, Top1 = 60 cm, EW = -24 cm
Coverage:
Single source union = 0.0 %
Double source intersection = 0.0 %
1200
900
600
300
0
Y [cm]
300
0
X [cm]

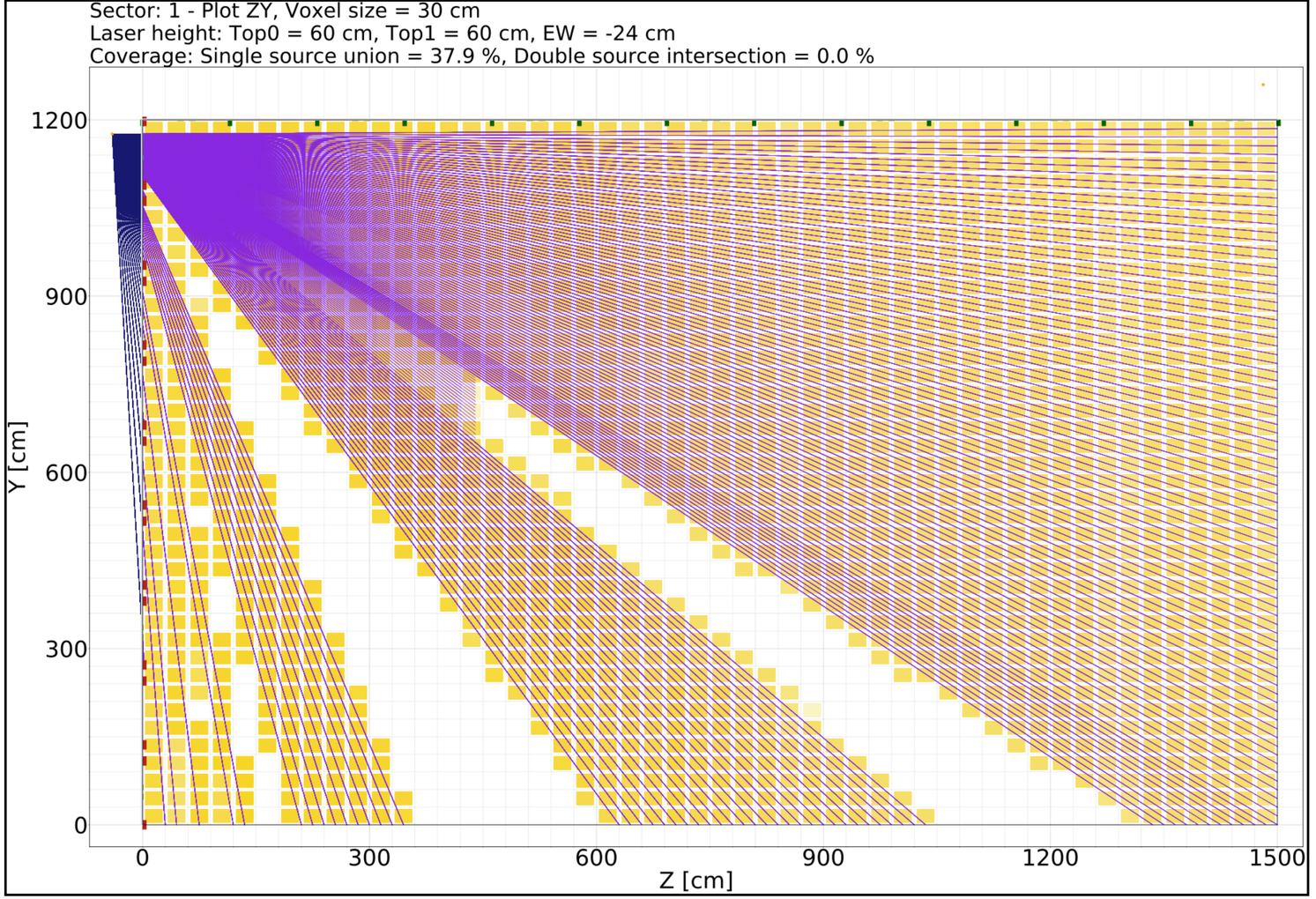

Sector: NE - Plot XY, Voxel size = 30 cm
Laser height:
Top0 = 60 cm, Top1 = 60 cm, EW = -24 cm
Coverage:
Single source union = 0.0 %
Double source intersection = 0.0 %
1200
900
600
300
0
Y [cm]
300
0
X [cm]

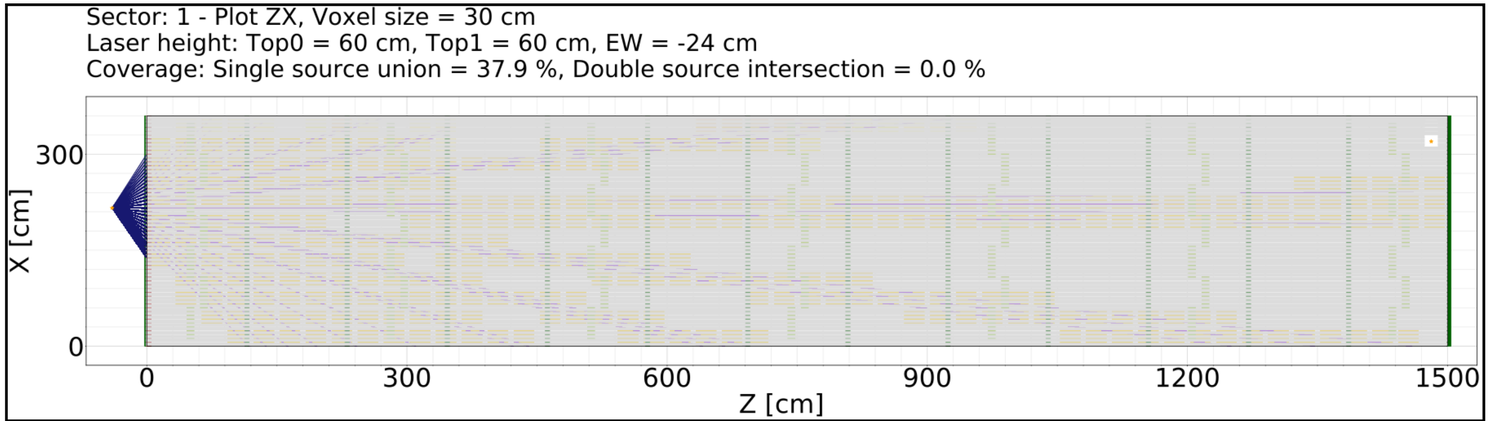
Secondary source only
1 V, **End-wall** sector

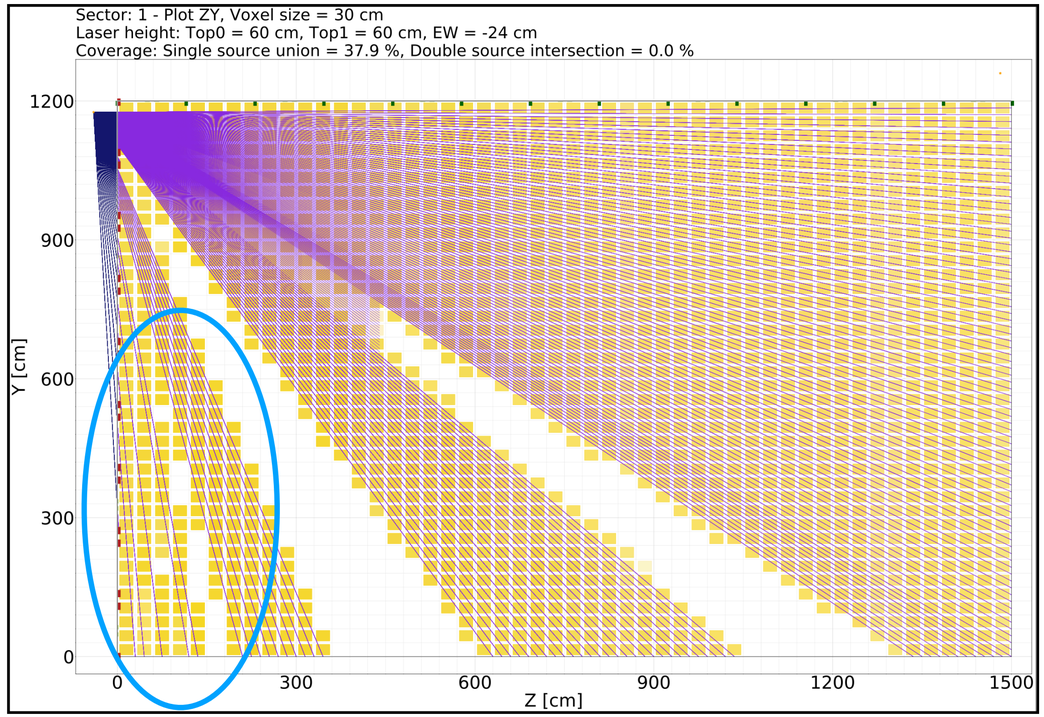
No-APA filter ON

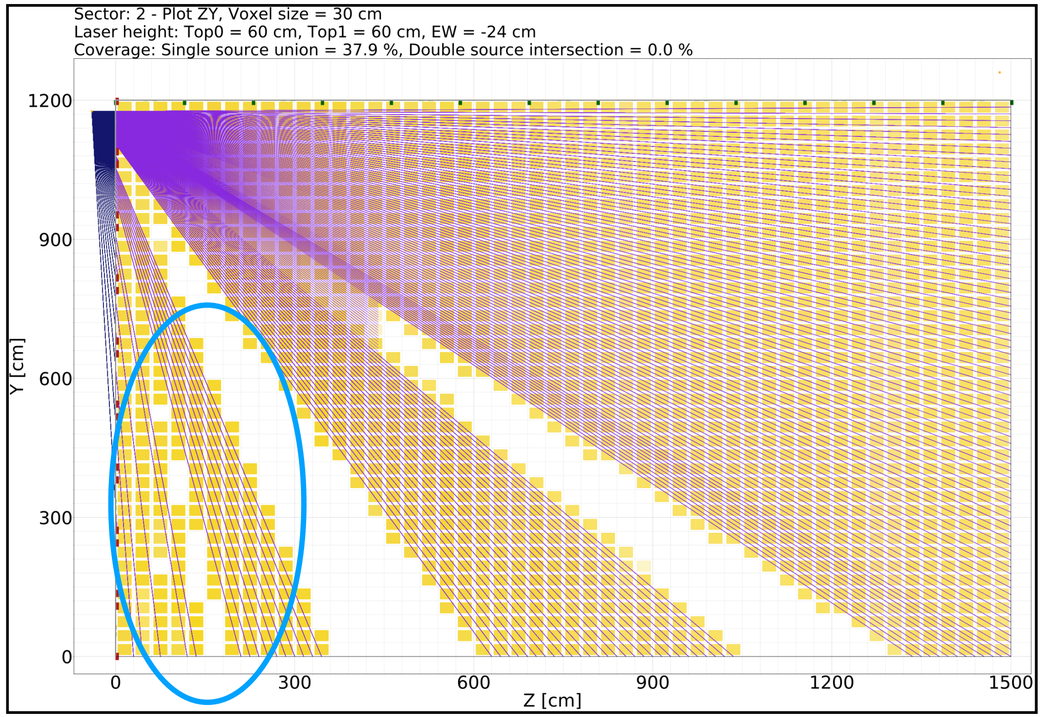
Tracks are prevented from reaching the APA plan

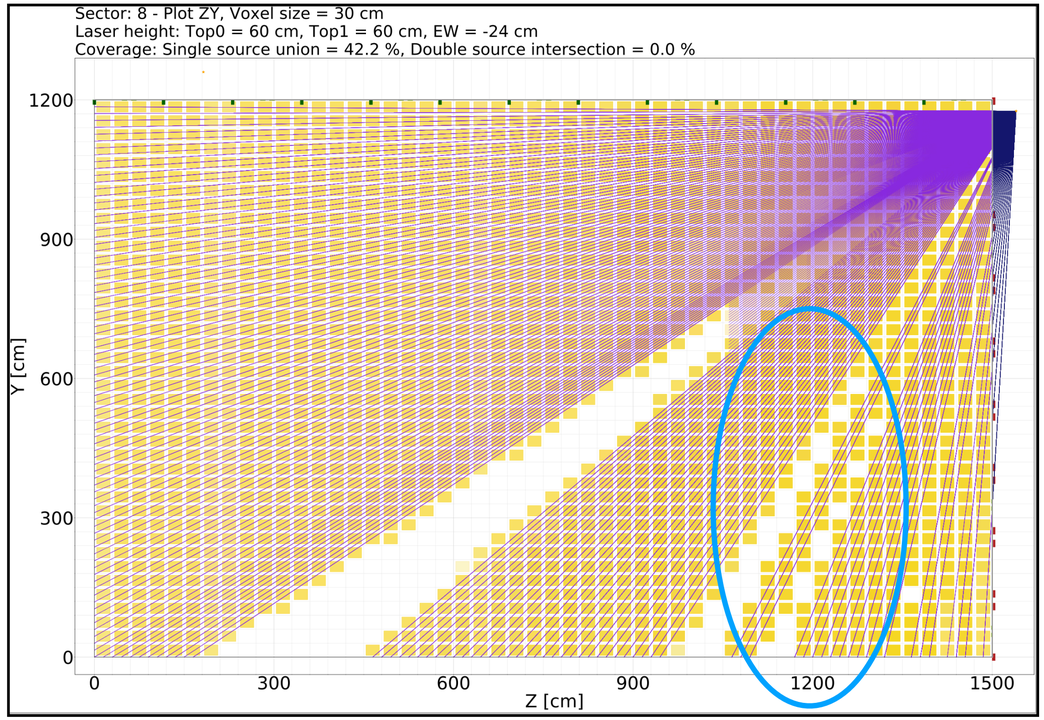


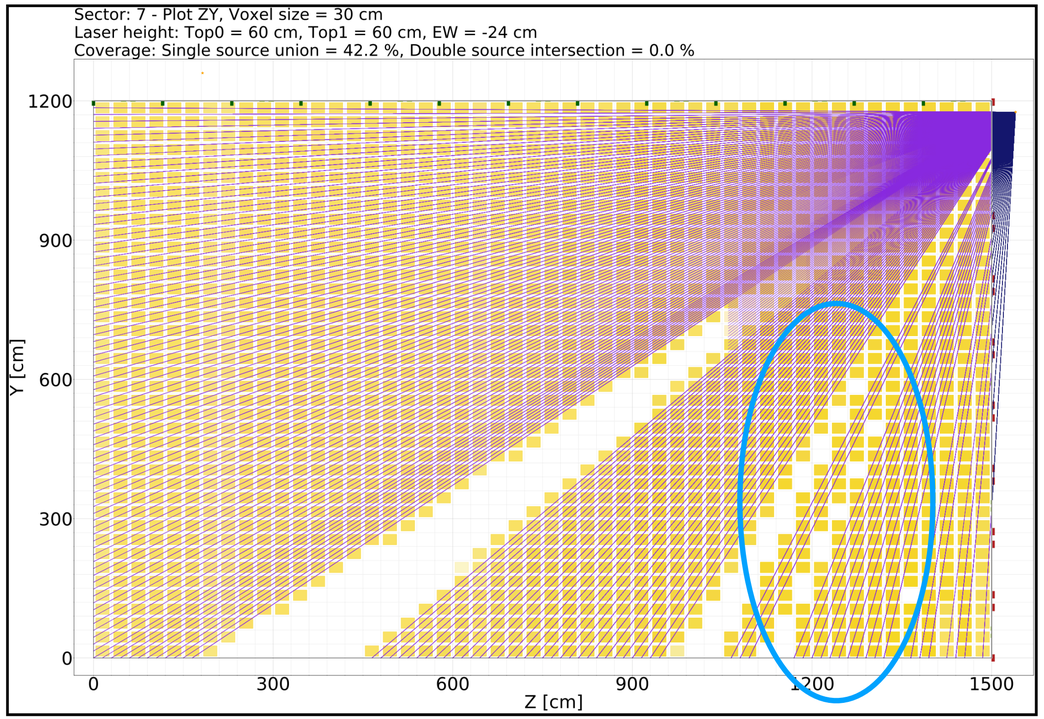






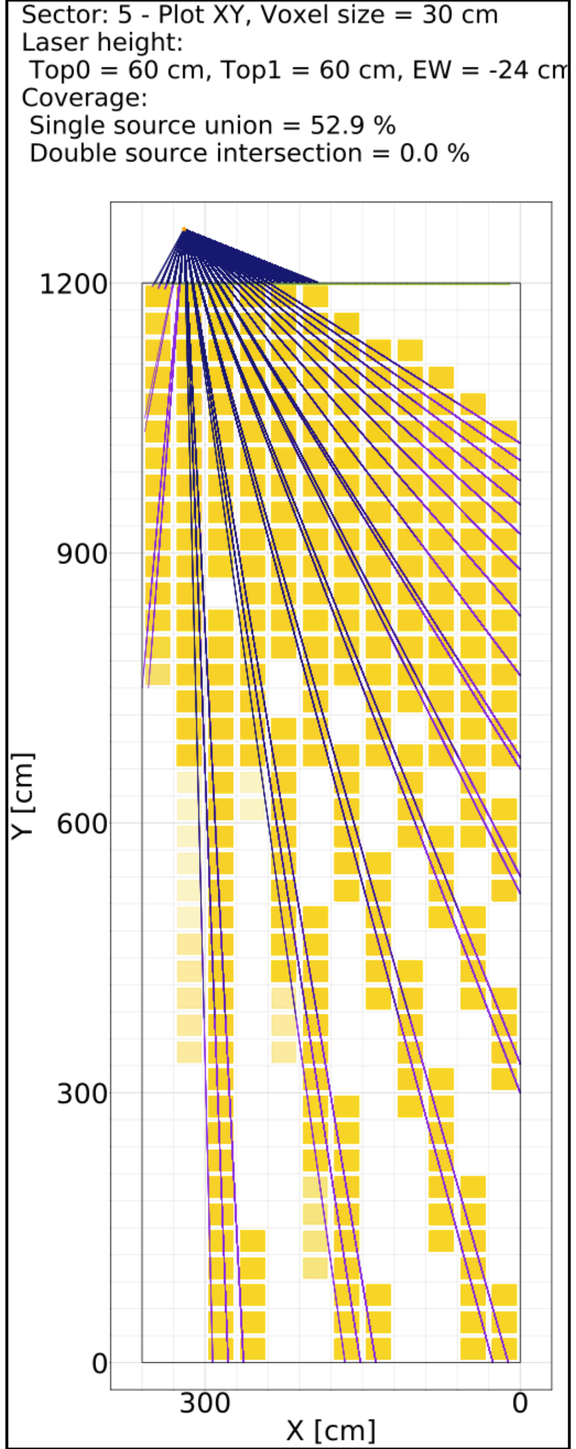


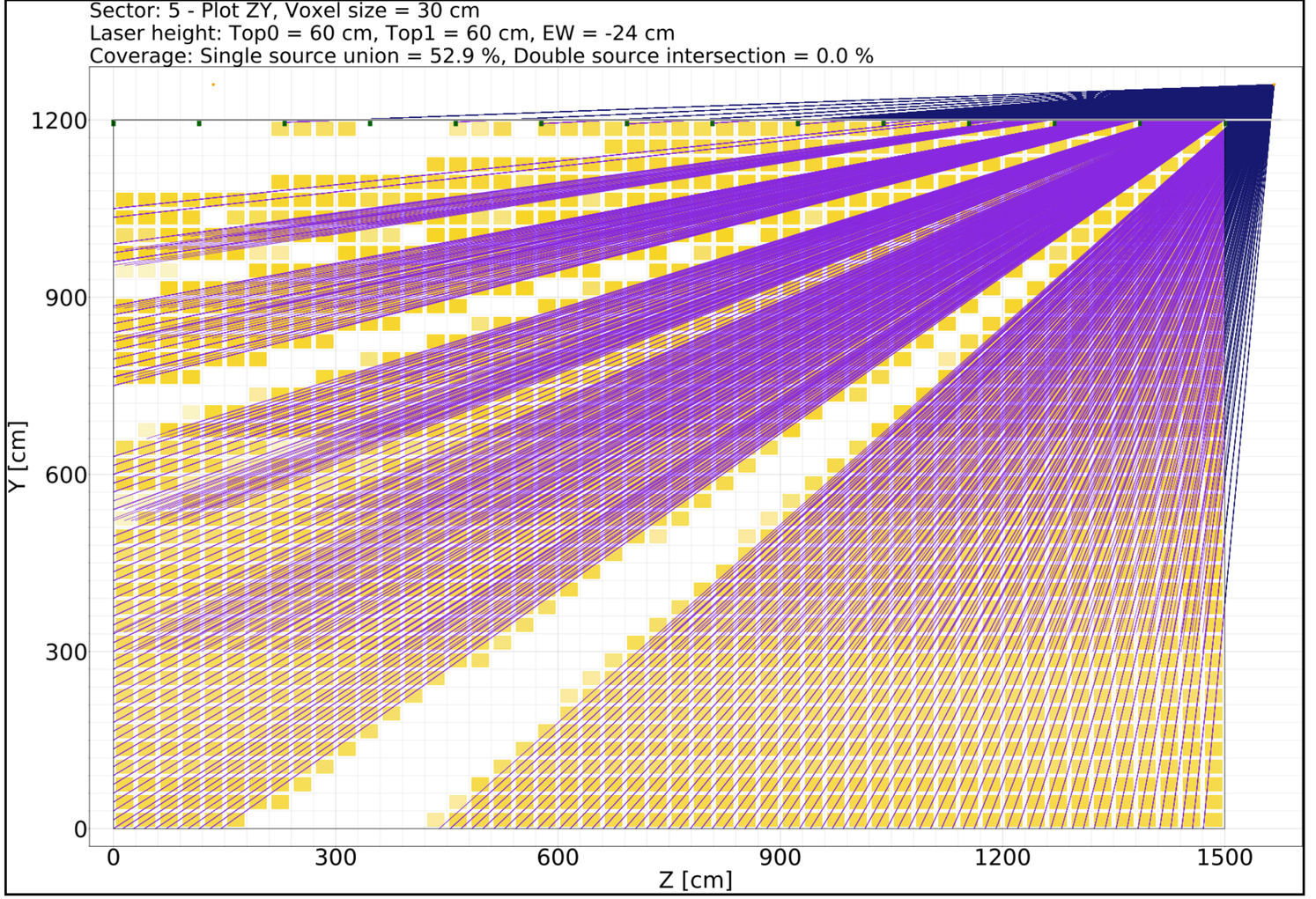


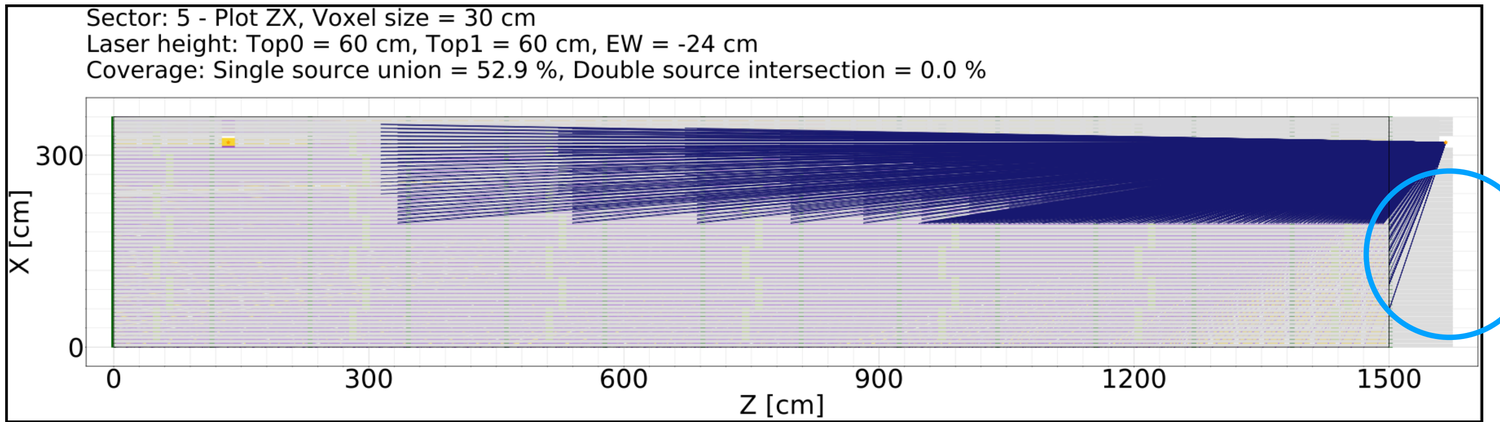


Secondary source only
1 V, **End-wall** sector

Small coverage differences due to small different obstacle-rejection of tracks

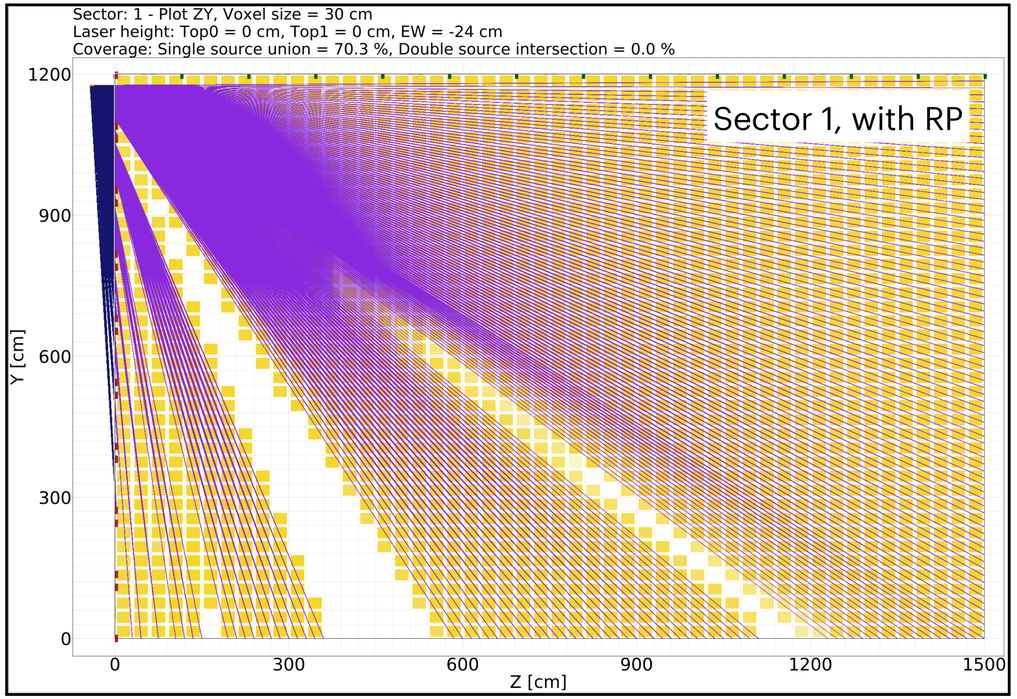


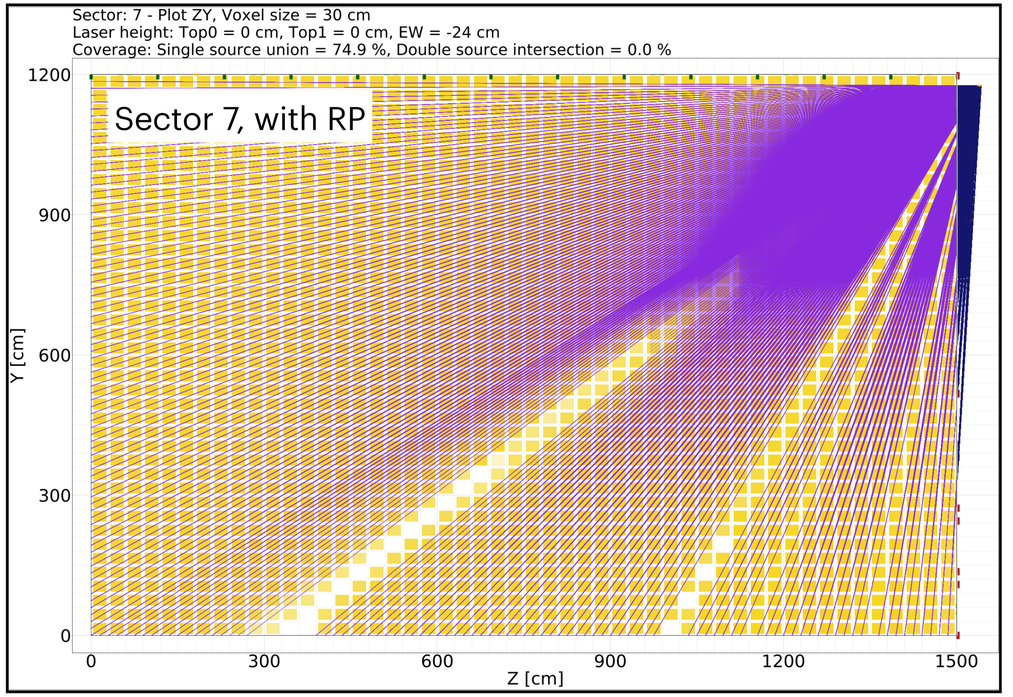


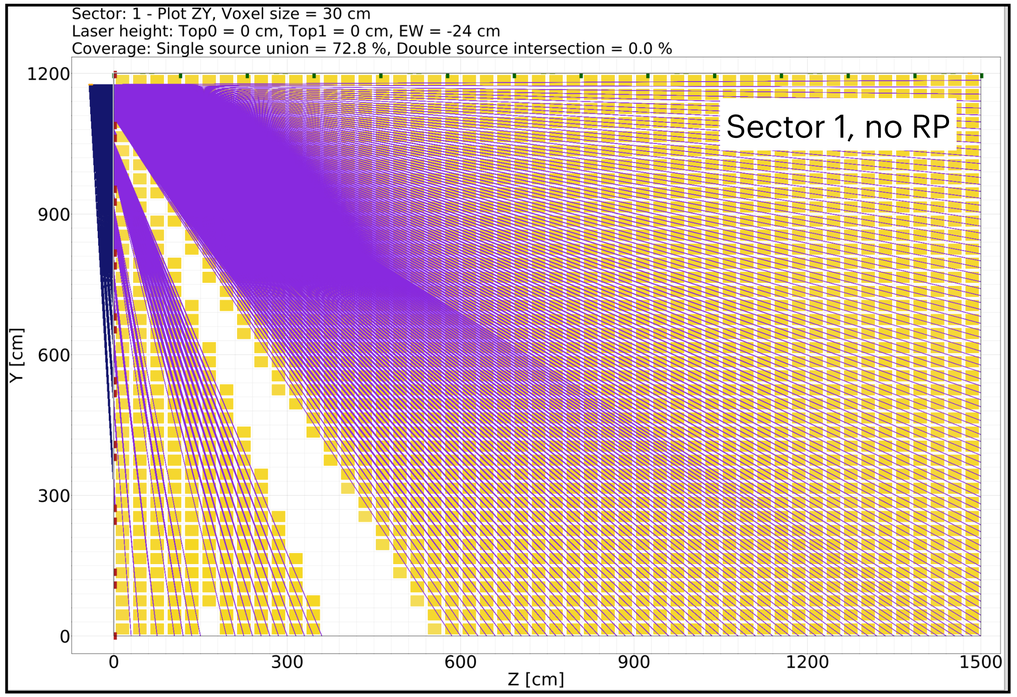


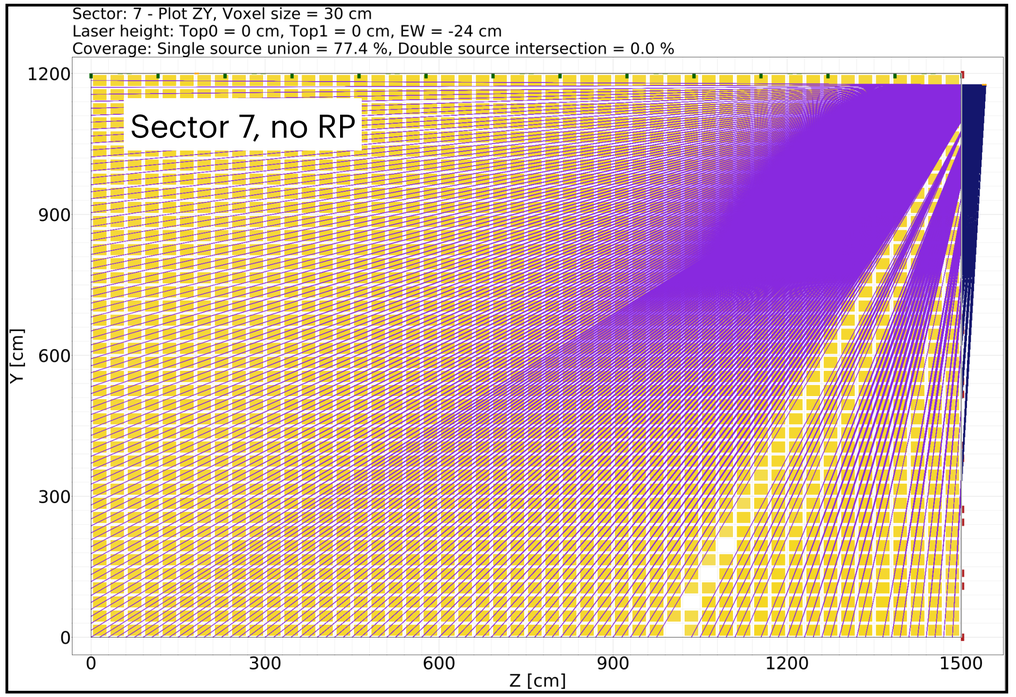
Secondary source only
1 V, **Internal** sector

Tracks outside the sector volume are represented in dark blue even if they are below the top of the field cage









Secondary source only
5V, **End-wall** sectors

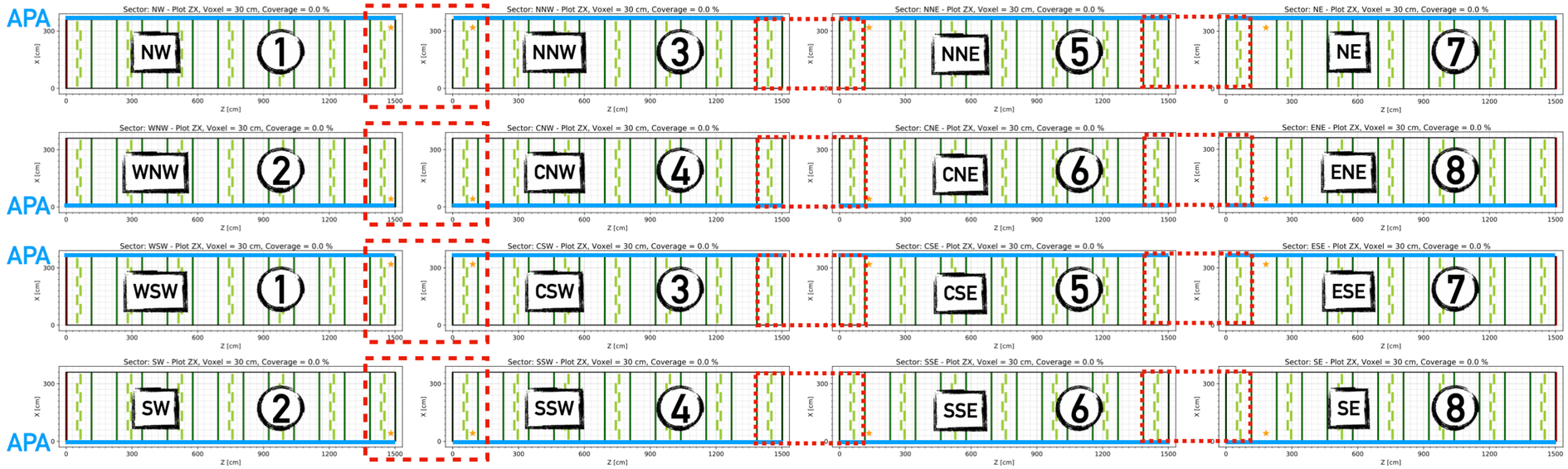
End-wall calculation, 1V

	A	B	C	D	E	F	G	H	I	J
1	Sector	vLaserOffsetTop0	vLaserOffsetTop1	vLaserOffsetEW	ifAPA	stdObs	coverage_primary_source	coverage_secondary_source	coverage_union	coverage_intersection
2	1	0	0	-24	FALSE	FALSE	0	40.73	40.73	0
3	2	0	0	-24	FALSE	FALSE	0	40.73	40.73	0
4	7	0	0	-24	FALSE	FALSE	0	44.84	44.84	0
5	8	0	0	-24	FALSE	FALSE	0	44.84	44.84	0

no End-wall Resistor Plates

	A	B	C	D	E	F	G	H	I	J
1	Sector	vLaserOffsetTop0	vLaserOffsetTop1	vLaserOffsetEW	ifAPA	stdObs	coverage_primary_source	coverage_secondary_source	coverage_union	coverage_intersection
2	1	60	60	-24	FALSE	TRUE	0.00	37.93	37.93	0.00
3	2	60	60	-24	FALSE	TRUE	0.00	37.93	37.93	0.00
4	7	60	60	-24	FALSE	TRUE	0.00	42.21	42.21	0.00
5	8	60	60	-24	FALSE	TRUE	0.00	42.21	42.21	0.00

with End-wall Resistor Plates



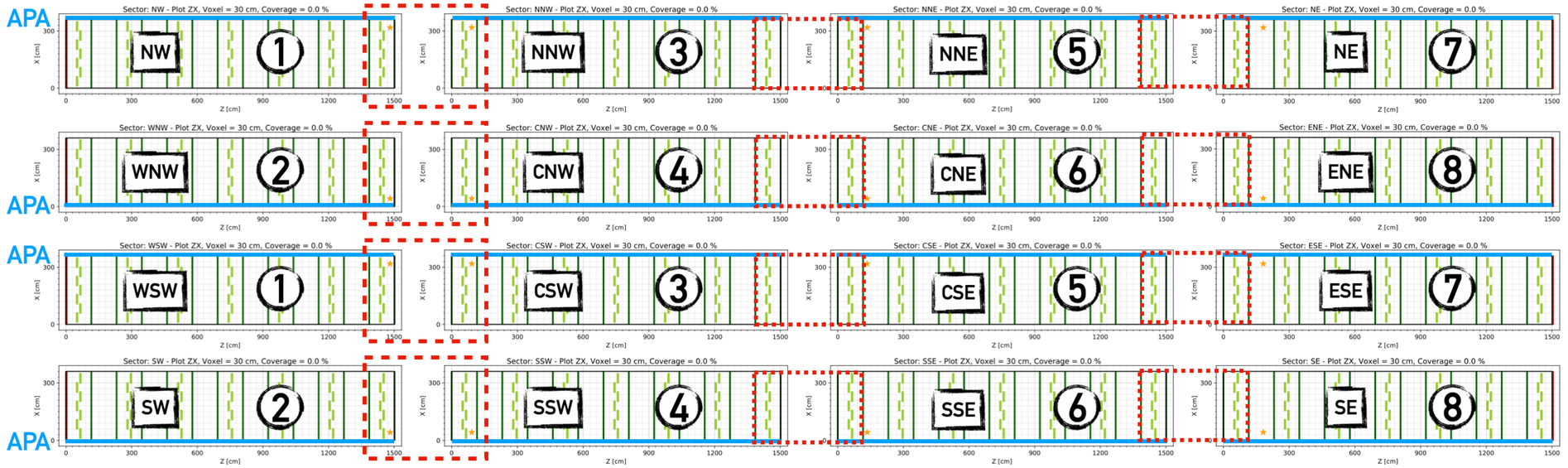
End-wall calculation, 5V

	A	B	C	D	E	F	G	H	I	J
1	Sector	vLaserOffsetTop0	vLaserOffsetTop1	vLaserOffsetEW	ifAPA	stdObs	coverage_primary_source	coverage_secondary_source	coverage_union	coverage_intersection
2	1	0	0	-24	FALSE	FALSE	0.00	72.80	72.80	0.00
3	2	0	0	-24	FALSE	FALSE	0.00	72.80	72.80	0.00
4	7	0	0	-24	FALSE	FALSE	0.00	77.41	77.41	0.00
5	8	0	0	-24	FALSE	FALSE	0.00	77.41	77.41	0.00

no End-wall Resistor Plates

	A	B	C	D	E	F	G	H	I	J
1	Sector	vLaserOffsetTop0	vLaserOffsetTop1	vLaserOffsetEW	ifAPA	stdObs	coverage_primary_source	coverage_secondary_source	coverage_union	coverage_intersection
2	1	0	0	-24	FALSE	TRUE	0.00	70.26	70.26	0.00
3	2	0	0	-24	FALSE	TRUE	0.00	70.26	70.26	0.00
4	7	0	0	-24	FALSE	TRUE	0.00	74.89	74.89	0.00
5	8	0	0	-24	FALSE	TRUE	0.00	74.89	74.89	0.00

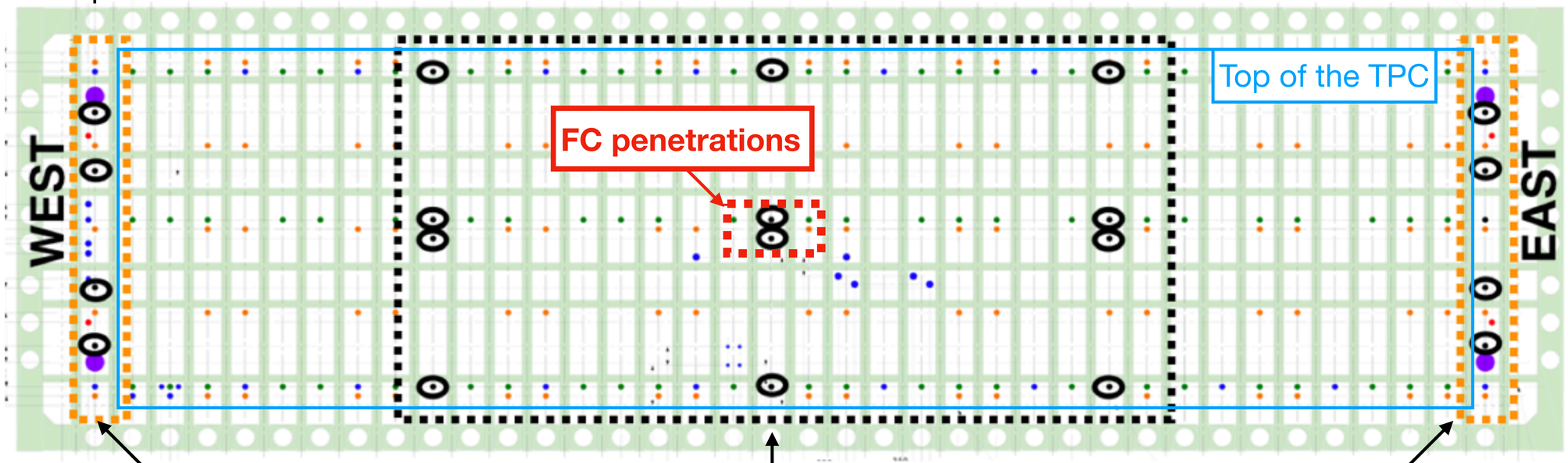
with End-wall Resistor Plates

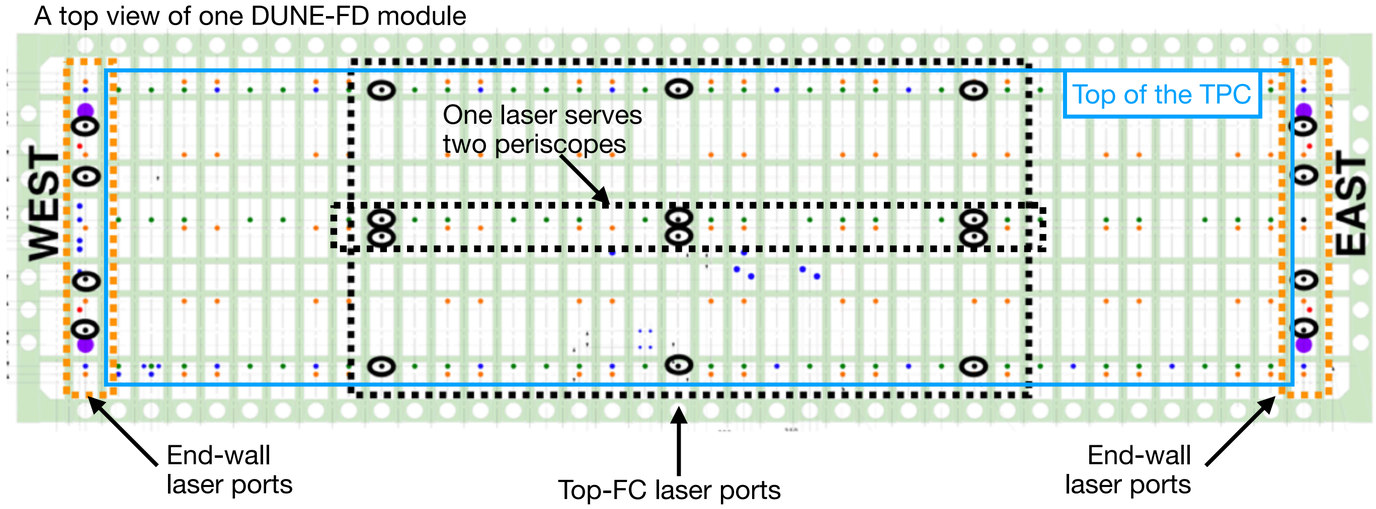


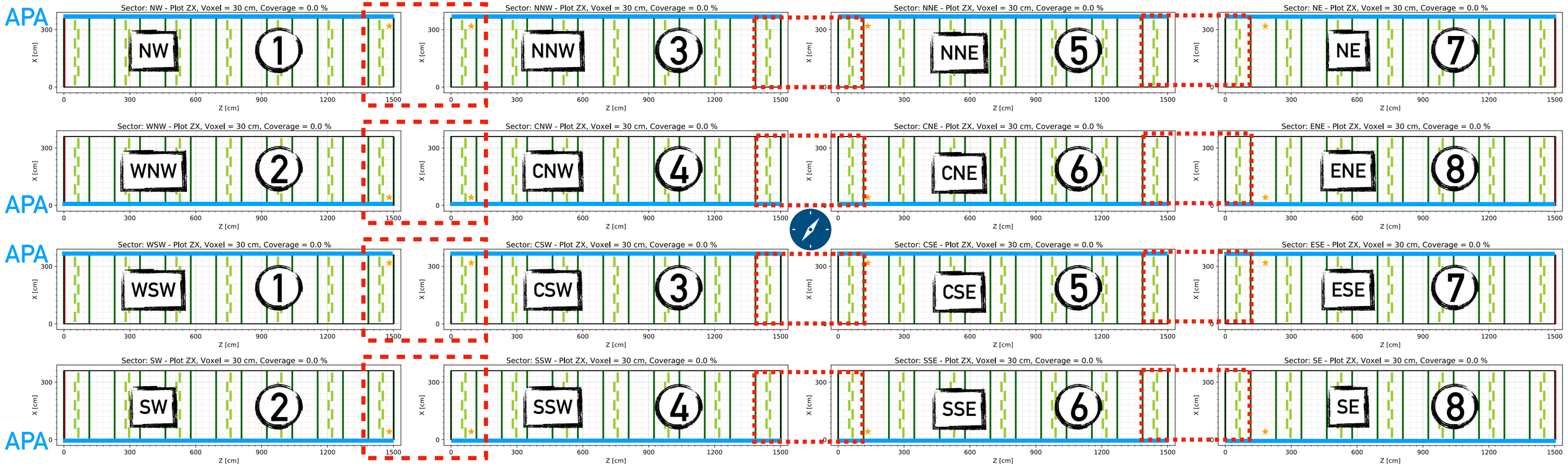
Building a full simulation

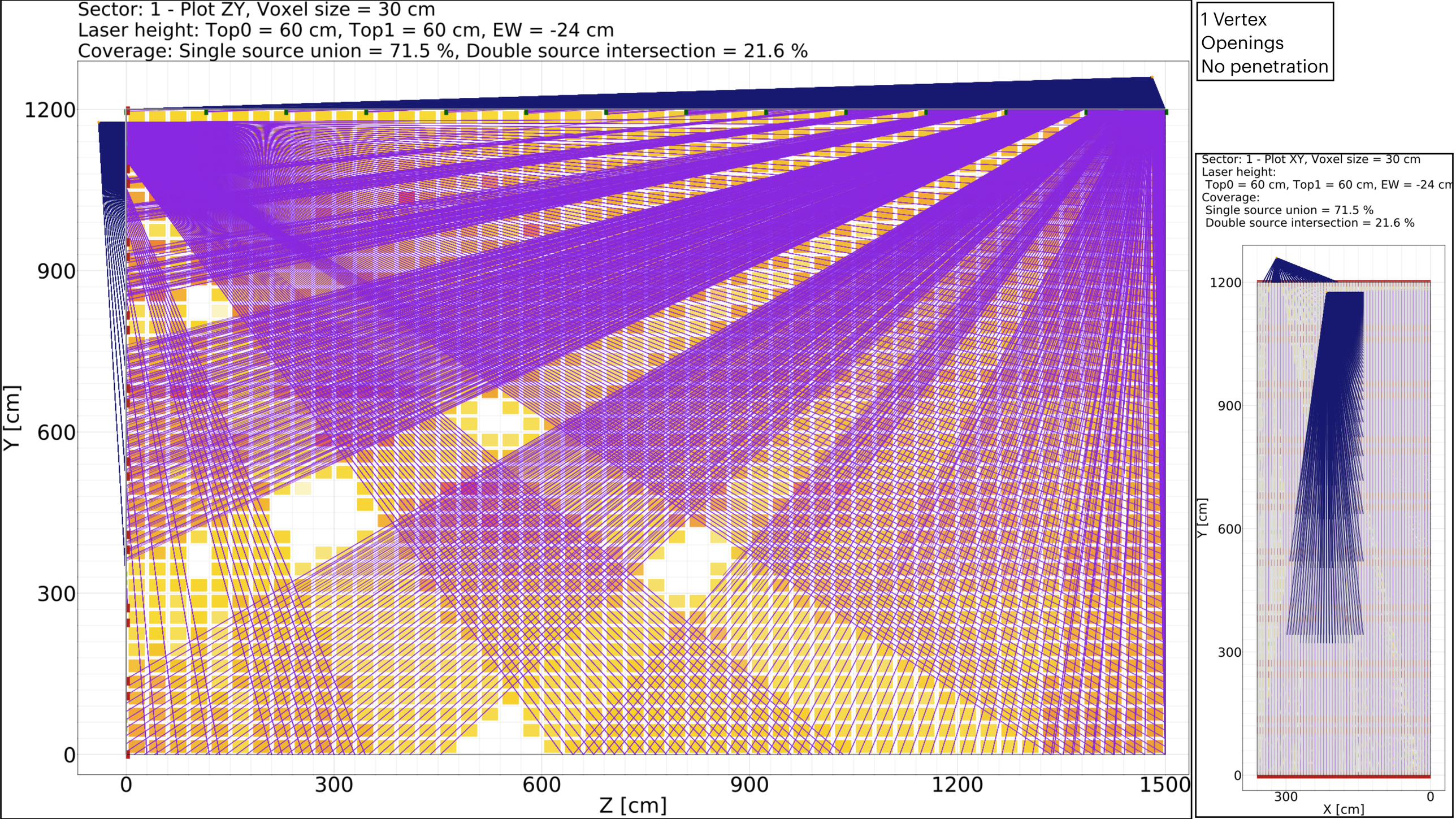
Entire DUNE-FD module 2 sources per sector, 16 different sectors, All obstacles (EW only at best understanding), ‘Realistic’ penetrations

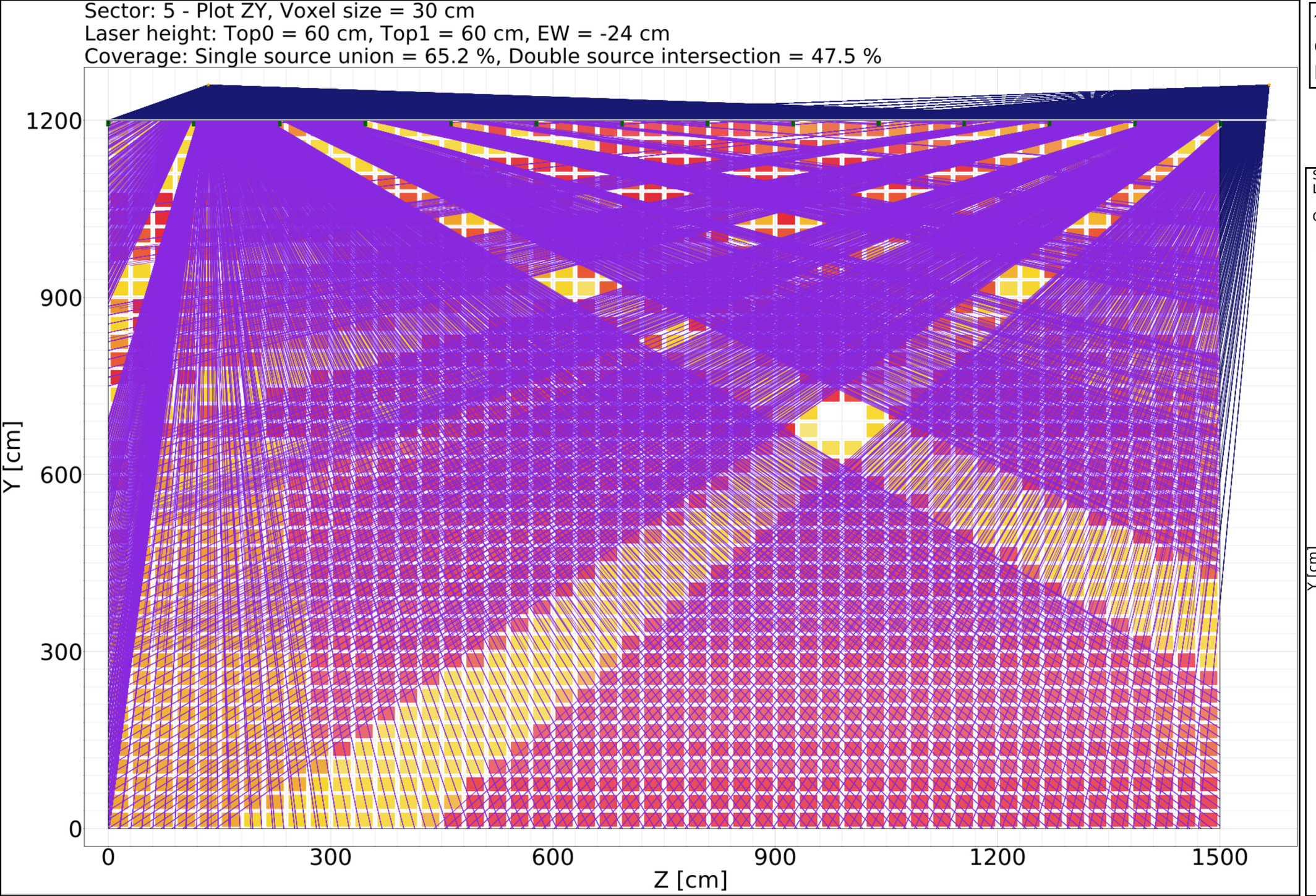
A top view of one DUNE-FD module



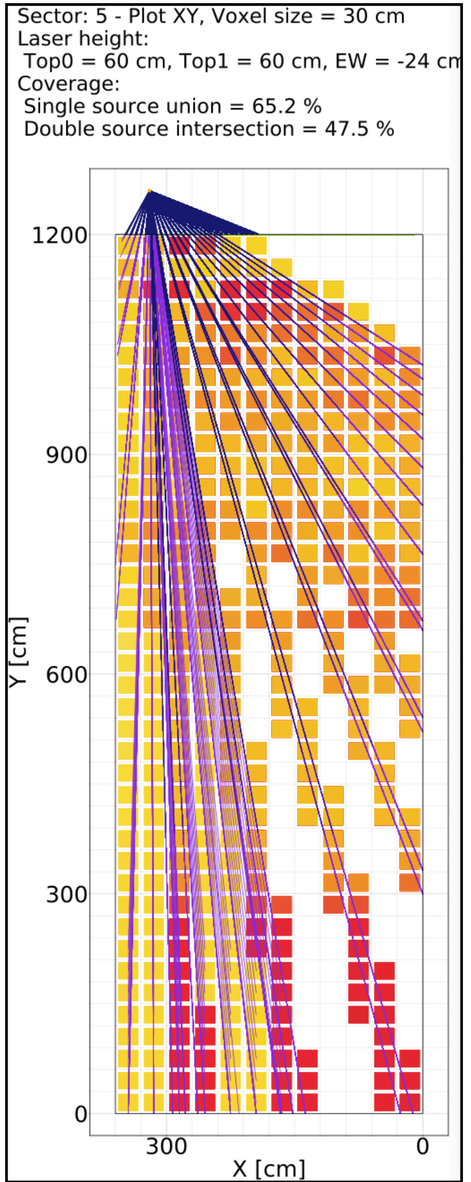

A top view of one DUNE-FD module
WEST
EAST
One laser serves
two periscopes
Top of the TPC
End-wall
laser ports
Top-FC laser ports
End-wall
laser ports


APA
APA
APA
APA
Sector: NW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
NW
1
Sector: NNW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
NNW
3
Sector: NNE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
NNE
5
Sector: NE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
NE
7
Sector: WNW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
WNW
2
Sector: CNW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
CNW
4
Sector: CNE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
CNE
6
Sector: ENE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
ENE
8
Sector: WSW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
WSW
1
Sector: CSW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
CSW
3
Sector: CSE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
CSE
5
Sector: ESE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
ESE
7
Sector: SW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
SW
2
Sector: SSW - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
SSW
4
Sector: SSE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
SSE
6
Sector: SE - Plot ZX, Voxel = 30 cm, Coverage = 0.0 %
SE
8
X [cm]
Z [cm]


Sector: 1 - Plot ZY, Voxel size = 30 cm
Laser height: Top0 = 60 cm, Top1 = 60 cm, EW = -24 cm
Coverage: Single source union = 71.5 %, Double source intersection = 21.6 %
1 Vertex
Openings
No penetration
1200
900
600
300
0
Y [cm]
0
300
600
900
1200
1500
Z [cm]
Sector: 1 - Plot XY, Voxel size = 30 cm
Laser height:
Top0 = 60 cm, Top1 = 60 cm, EW = -24 cm
Coverage:
Single source union = 71.5 %
Double source intersection = 21.6 %
1200
900
600
300
0
Y [cm]
300
0
X [cm]

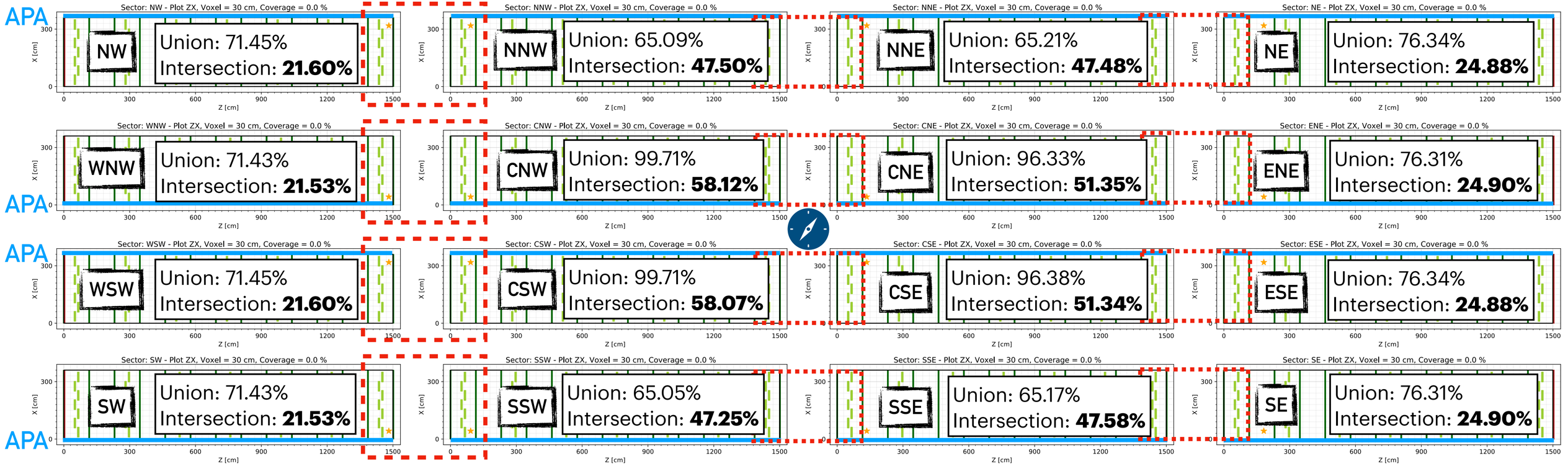


1 Vertex
Openings
No penetration



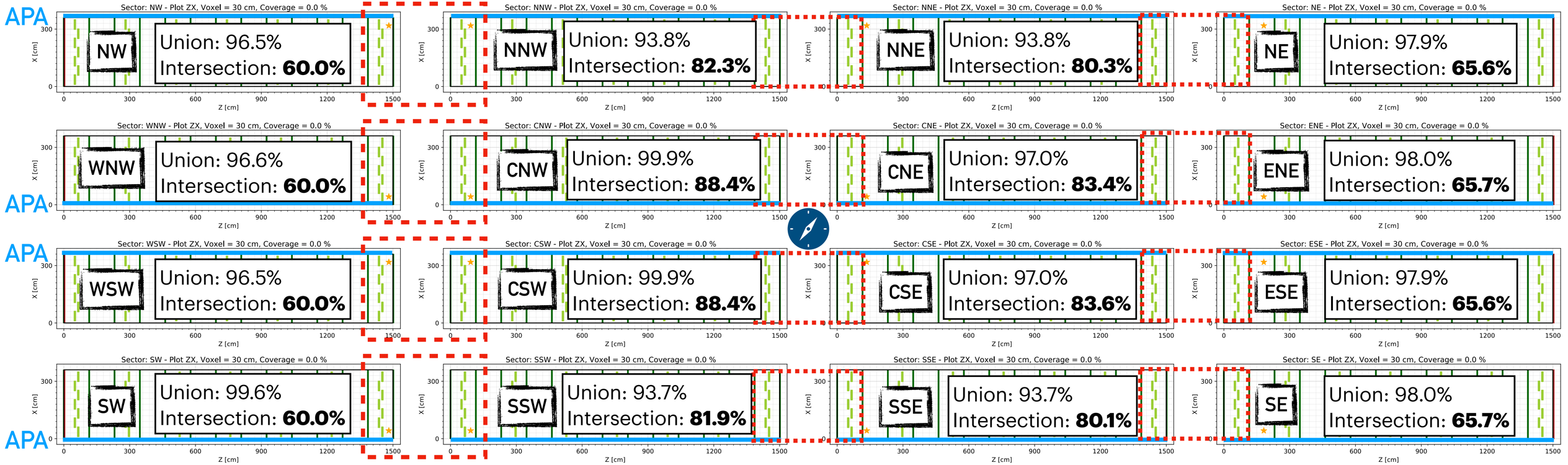
Full simulation, 1V

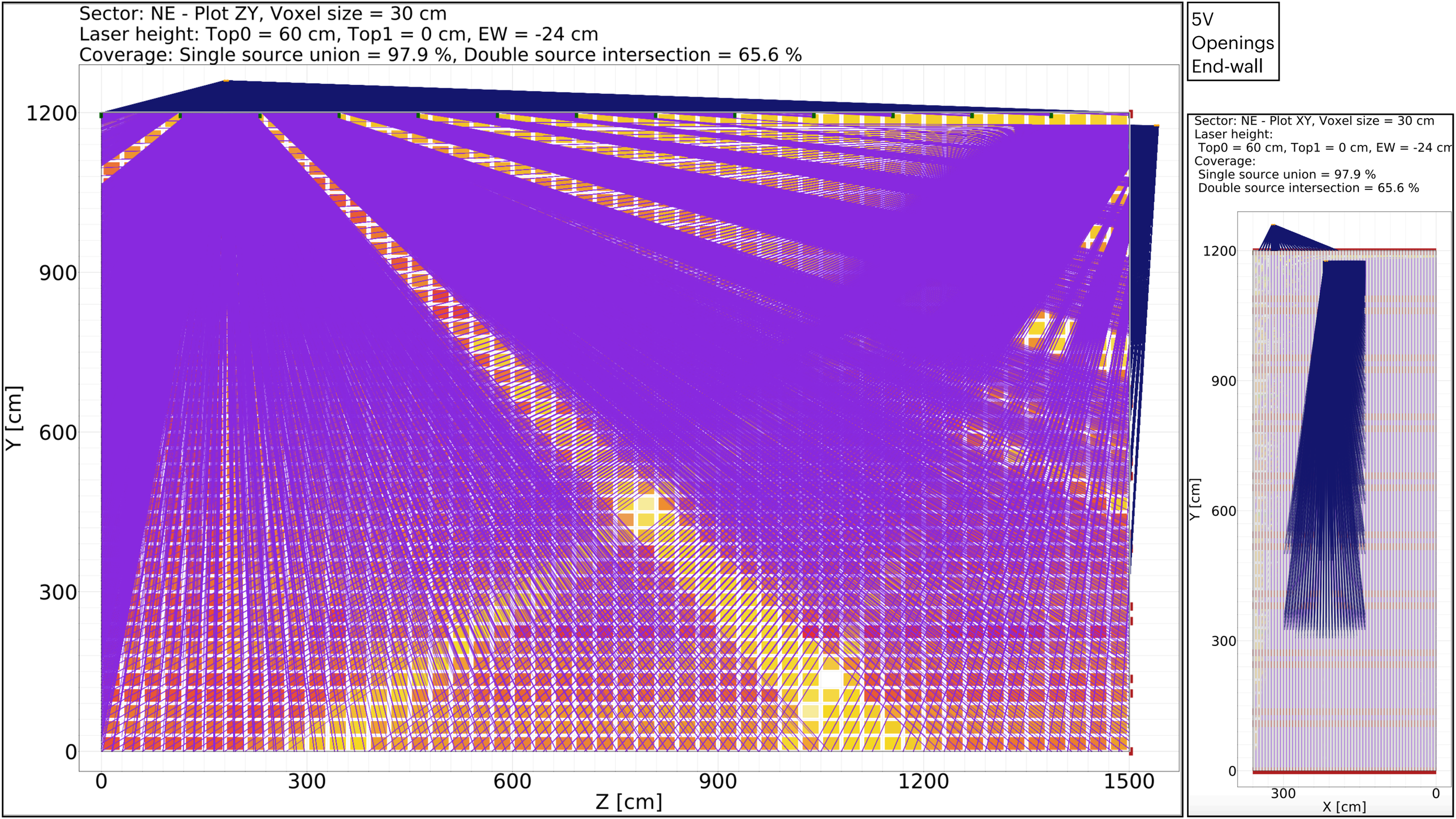
End-wall laser height: -24 cm
Top-FC primary source: 60 cm
Top-FC secondary source: 60 cm
Penetration: -24 cm



Full simulation, 5V

End-wall laser height: -24 cm
Top-FC primary source: 60 cm
Top-FC secondary source: 60 cm
Penetration: -24 cm




Sector: NE - Plot ZY, Voxel size = 30 cm
Laser height: Top0 = 60 cm, Top1 = 0 cm, EW = -24 cm
Coverage: Single source union = 97.9 %, Double source intersection = 65.6 %
5V
Openings
End-wall
Y [cm]
1200
900
600
300
0
0
300
600
900
1200
1500
Z [cm]
Sector: NE - Plot XY, Voxel size = 30 cm
Laser height:
Top0 = 60 cm, Top1 = 0 cm, EW = -24 cm
Coverage:
Single source union = 97.9 %
Double source intersection = 65.6 %
Y [cm]
1200
900
600
300
0
300
0
X [cm]

Next

- End-wall scan; understand EWRP pattern
- Fix Pandas dataframes output to export histogram data
- Simulate periscope geometry